

Port Authority



EQUITY INDEX OF MOBILITY NEED

PORT AUTHORITY OF ALLEGHENY COUNTY

Planning Department
2019

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System Overview

The Port Authority of Allegheny County (PAAC) exists to provide public transportation options in Allegheny County in southwestern Pennsylvania. The organization serves 775 square mile area within and immediately adjacent to Allegheny County. The services include 97 bus routes (three of which are fixed guideways, or busways, which run along designated, bus-only roads), three light rail routes, and 2 inclined planes (funiculars), one of which is operated by an outside entity. Port Authority also sponsors the ACCESS paratransit program, which provides door-to-door, advance reservation, shared ride service which is contracted through a third party provider. These services are all supported by almost 7,000 transit stops and stations, 700 shelters, 53 Park and Ride lots, 119 locations where customers can purchase fare cards and tickets, and various operational centers (including one light rail center, four bus garages, one heavy maintenance bus facility, and one general maintenance facility).

Port Authority of Allegheny County strives to provide quality service in a manner that is efficient, effective and equitable. To do so, PAAC must make a number of decisions based on competing priorities about where demand is greatest, which type of service would work best and be most appropriate and where limited resources can and should be used. To make the Port Authority of Allegheny County's decision-making process as fair, consistent and transparent as possible, the organization has developed a set of service guidelines.

These Transit Service Guidelines are general guides for the base level of service that act as an aid to the decision making process for changes to service. They are used to develop service change recommendations and are used on an ongoing basis to evaluate, adjust and improve services as demand and conditions change.

Equity Index

Incoming requests for major changes to service need to be evaluated in terms of efficiency, effectiveness and equity to ensure the service goals are met. Equity evaluation serves to identify areas that have a higher proportion of disadvantaged populations or populations that may have greater mobility needs. This evaluation is completed through the development of an equity index of various demographic factors to give areas an equity "score". Areas that score higher in the equity evaluation process are considered higher priority areas for the Port Authority to serve.

Port Authority is required to look at various disadvantaged populations under various Federal laws. In accordance with the Title VI program of the Civil Rights Act of 1965, the Port Authority of Allegheny County is required to ensure that the provision of its services does not have a disparate impact on minority race or ethnicity populations. It is also mentioned that this requirement can be extended to include other constituencies that are traditionally underserved, such as people with disabilities, people with limited English proficiency, etc. Additionally, even though low-income populations are not protected under Title VI, transit providers are required by the Federal Transit Authority (FTA) to ensure proposed service changes do not disproportionately burden them if other alternatives that aren't as burdensome exist.

As a way to expand upon Federal requirements and further the agency's equity goals, the Authority started evaluating major service changes according to 5 groups of people who may have greater mobility needs:

- Low income households (protected under Title VI)
- Minority race and ethnicity populations (protected under Title VI)
- Households with older adults (over age 65) (not protected)
- Persons with disabilities (protected under ADA but not as it relates to transit service)
- Households with no available vehicle (not protected)

Updates to the Equity Index

This document serves to update that original equity index of 5 populations to include new groups of people who also might have greater mobility needs. The decision to include new metrics was made by conducting research and having discussions with other agencies that have similar indices.

The City of Pittsburgh is developing an equity index that includes persons of limited English proficiency, persons of a minority race, Hispanic persons, low income households, children, teens, persons with a disability, no vehicle households, female householder (no husband), and persons over age 65 in their index. The City of Oakland, California also has an equity index where they additionally incorporated single parent families and cost-burdened renters. Finally, the Delaware Valley Regional Planning Commission (DVRPC) in eastern Pennsylvania termed “Indicators of Potential Disadvantage (IPD)” includes youth, older adults, females, racial minorities, ethnic minorities, foreign-born persons, persons with limited English proficiency, persons with disabilities, and low-income households.

In the PAAC Equity Index, the “low income households” category was expanded to more broadly capture people in poverty, both where they live and where they may work. Factors that are included:

- Low income households (original index)
- Cost burdened renters (newly added)
- low wage jobs (newly added)

Additionally, the Persons with disabilities category was also expanded to capture more than one dataset. It now includes:

- Households with people with disabilities (original index)
- ACCESS paratransit trips (newly added)

Other new factors added are Households with limited English proficiency, People under age 18 and Single female families. Table 1 shows the factors used in the PAAC 2015 and 2019 indexes and the factors used in the index of other agencies.

Table 1: Comparison of metrics used for PAAC Equity Index in 2015, City of Pittsburgh Mobility Index, Delaware Valley Regional Planning Commission (DVRPC), City of Oakland, California and PAAC Equity Index in 2019.

Factors		PAAC Equity Index 2015	City of Pittsburgh Index	DVRPC	City of Oakland, CA	PAAC Equity Index 2019
Poverty	Low income households	✓	✓	✓	✓	✓
	Cost burdened renters				✓	✓
	Low wage jobs					✓
Persons with Disabilities	Households with persons with disabilities	✓	✓	✓	✓	✓
	ACCESS paratransit trips					✓
	Racial and ethnic minorities	✓			✓	✓
	Persons of limited English proficiency		✓	✓	✓	✓
	Households with no vehicle available	✓	✓		✓	✓
	Households with older adults (over age 65)	✓	✓	✓	✓	✓
	Households with persons under age 18			✓	✓	✓
	Female householder (no husband present)					✓
	Female head of households		✓		✓	
	Foreign-born persons			✓		
	Females			✓		
	Single parent household				✓	
	Household with children		✓			
	Household with teens		✓			
	Racial minorities		✓	✓		
	Ethnic minorities		✓	✓		

Methodology

The data acquisition, calculations, and scoring process for each category has been described in this section. All U.S. Census data was obtained at the block group level where available. Where unavailable, the Census tract level data was used.

1. People with Disabilities

People identified as having one or more disabilities. These could be the following types of disabilities as defined by the Census: ambulatory disabilities, cognitive disabilities, sensory disabilities, physical disabilities, mental disabilities, self-care disabilities, hearing difficulty, vision difficulty, independent living disabilities, or employment disabilities).

Two types of data were used to identify areas where people with disabilities live and travel to. One is Census data for households with one or more persons with a disability. And the other is the trip origin and destination data of the Authority's ACCESS paratransit program, which provides rides primarily for seniors and people with disabilities.

The data for persons with disabilities was obtained from the U.S. Census, labeled "households with one or more persons with a disability".¹ The percent of households with persons with disabilities among the total number of households was calculated for each Census block group. The distribution of percent of households with a person with a disability is shown in Figure 1. Then the block groups are sorted from highest to lowest for the percentage. Then the percent of households in each block group was normalized by the block group with the highest percentage. This meant the highest percentage will have a score of 1 and the other block groups will get respective scores lower than 1. This scoring process was followed for the other metrics discussed in this document.

¹ United states Census Bureau, *households with one or more persons with a disability (ACS 2016)*, <https://factfinder.census.gov/> (accessed August 6, 2018)

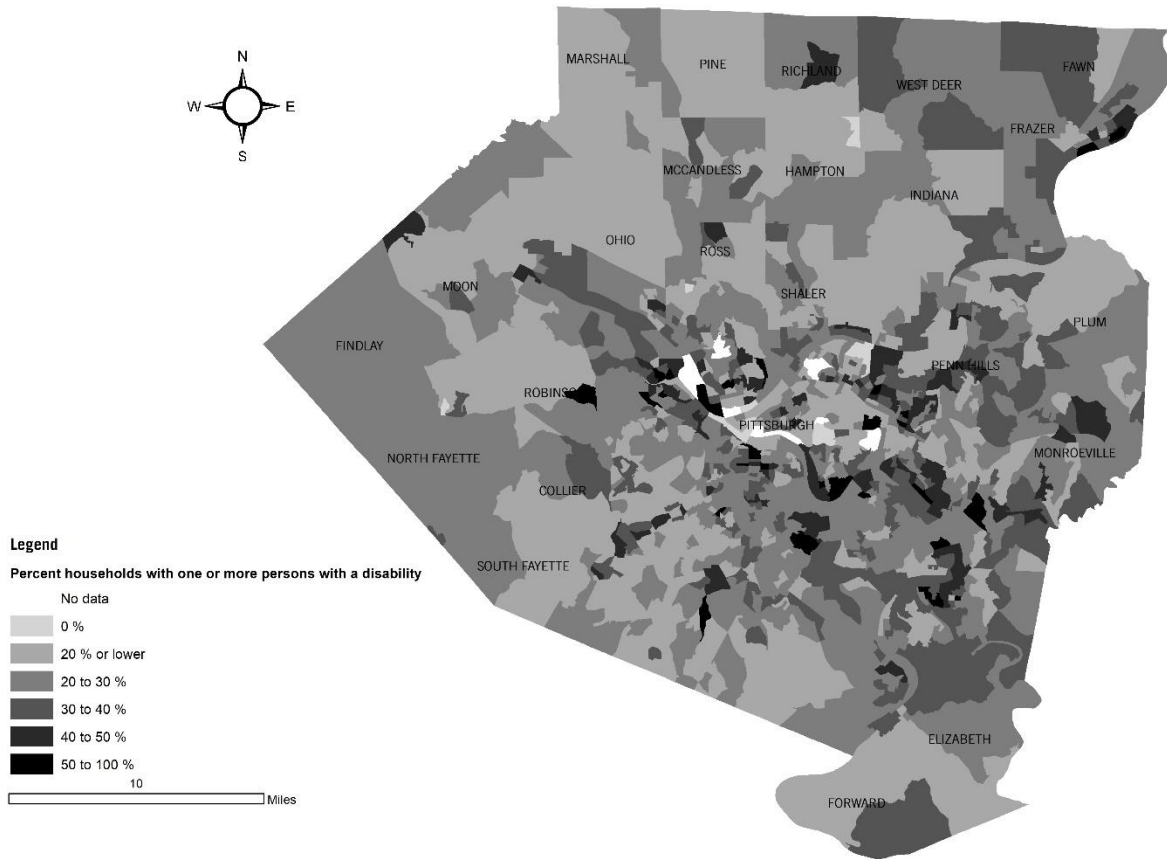


Figure 1: Map showing the percent distribution of households with one or more persons with a disability in Allegheny County

The ACCESS user data was obtained directly from ACCESS's database, where origin and destination of each trip is logged. The total number of ACCESS trips in 2016 was calculated, then the number of trips for each block group was divided by the total trip number to get the percentage of ACCESS trips in each Census block group. The distribution of percent of ACCESS trips in each block group is shown in Figure 2. Then the percent of ACCESS trips was sorted from highest to lowest. Then the percent of households in each block group was normalized by the block group with the highest percentage. This meant the highest percentage will have a score of 1 and the other block groups will get respective scores lower than 1. Finally, the scores for Households with one or more person with disability and ACCESS trips were averaged to get the final index for showing the distribution of people with disabilities in Allegheny County [Figure 3].

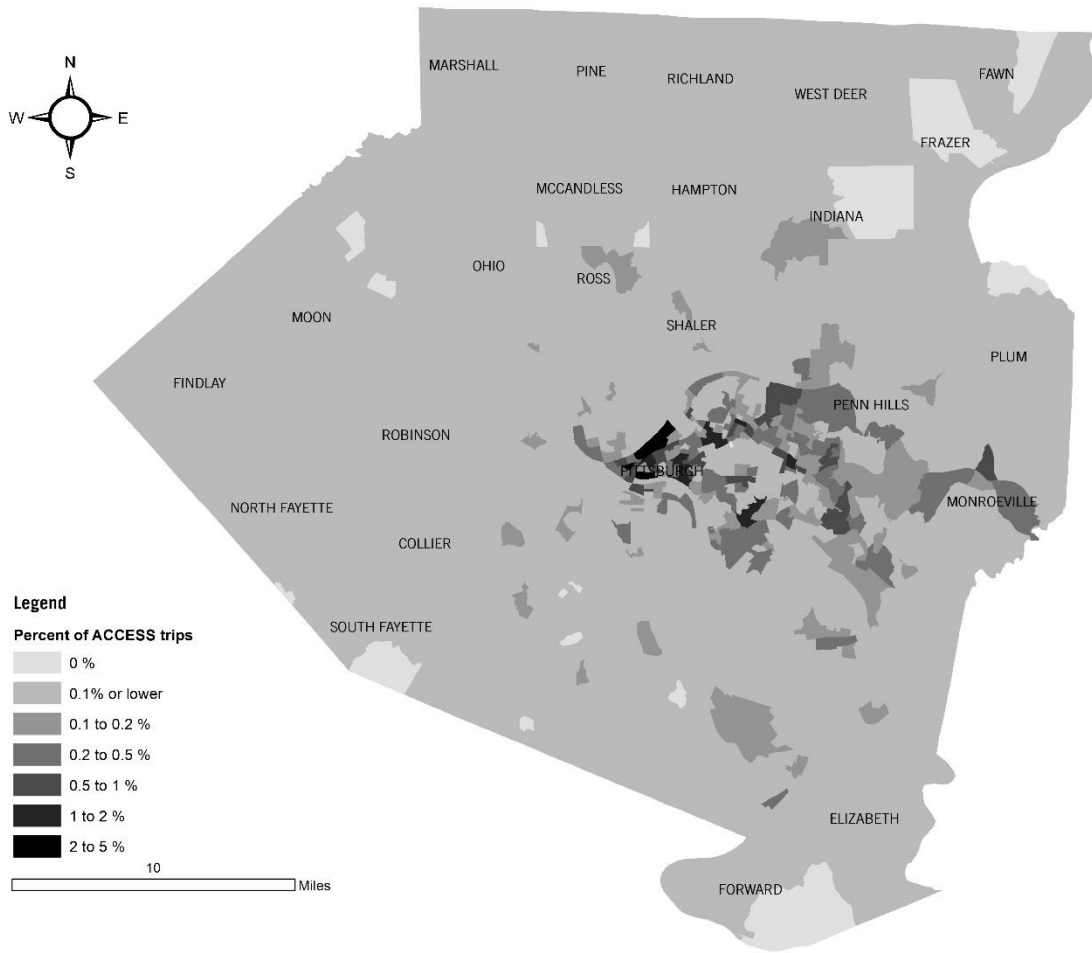


Figure 2: Map showing the distribution percent of ACCESS paratransit trips per Census block group in Allegheny County

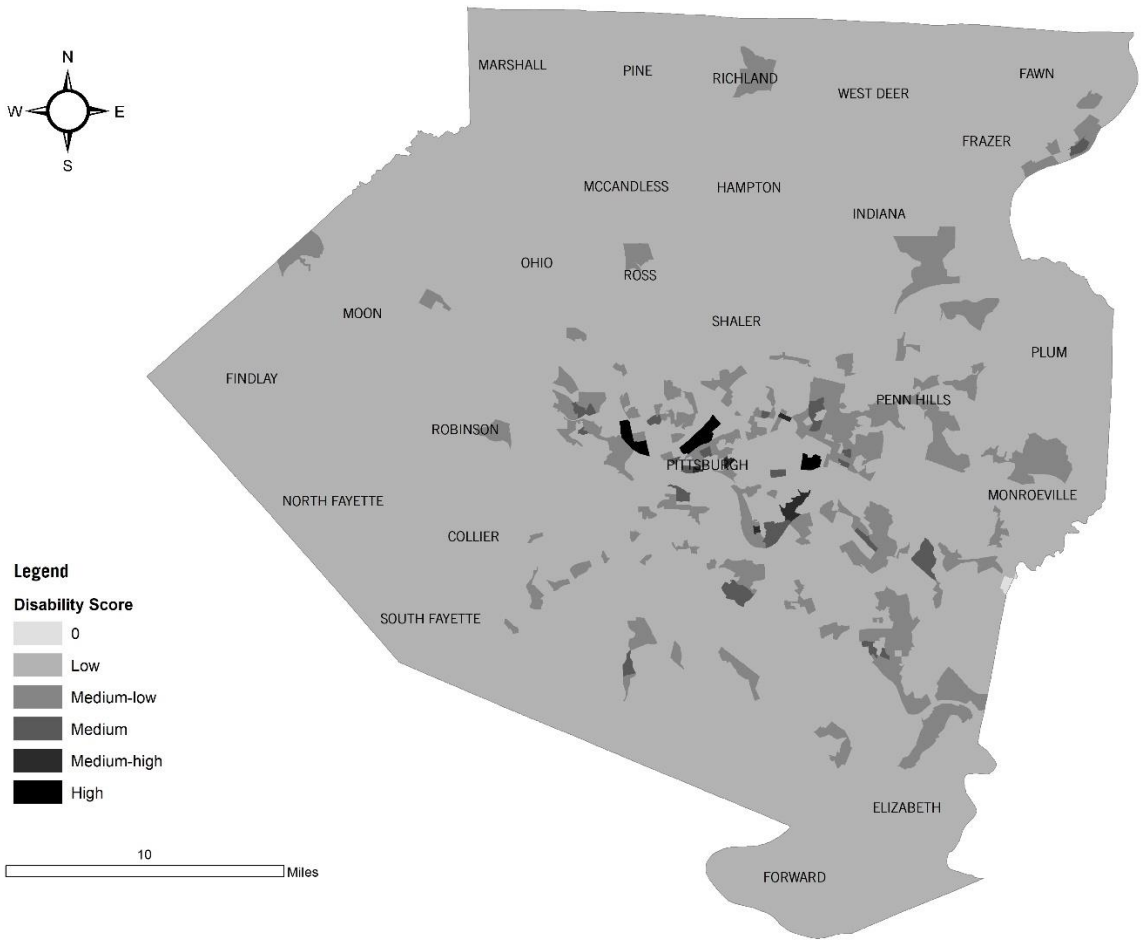


Figure 3: Map showing the distribution of persons with disabilities per Census block group in Allegheny County

2. People in Poverty

Three types of data would be used to capture the areas where people in poverty were living and/or working. Three data sets were used to identify these areas- household income, cost burdened renters, and locations of jobs.

The federal poverty line for a family of 4 in 2018 was \$25,100.² Therefore, Census data for households earning less than \$25,000 per year was used as an indicator of poverty for Allegheny County. Low income household data was also obtained from the U.S. Census. The data for “Household Income in The Past 12 Months (In 2016 Inflation-Adjusted Dollars)” was used.³ Number of households in the columns for income under \$25,000 per year were aggregated for each block group. The percent of low income households among the total households in each block group was calculated. The distribution of percent of households with low income is shown in Figure 4.

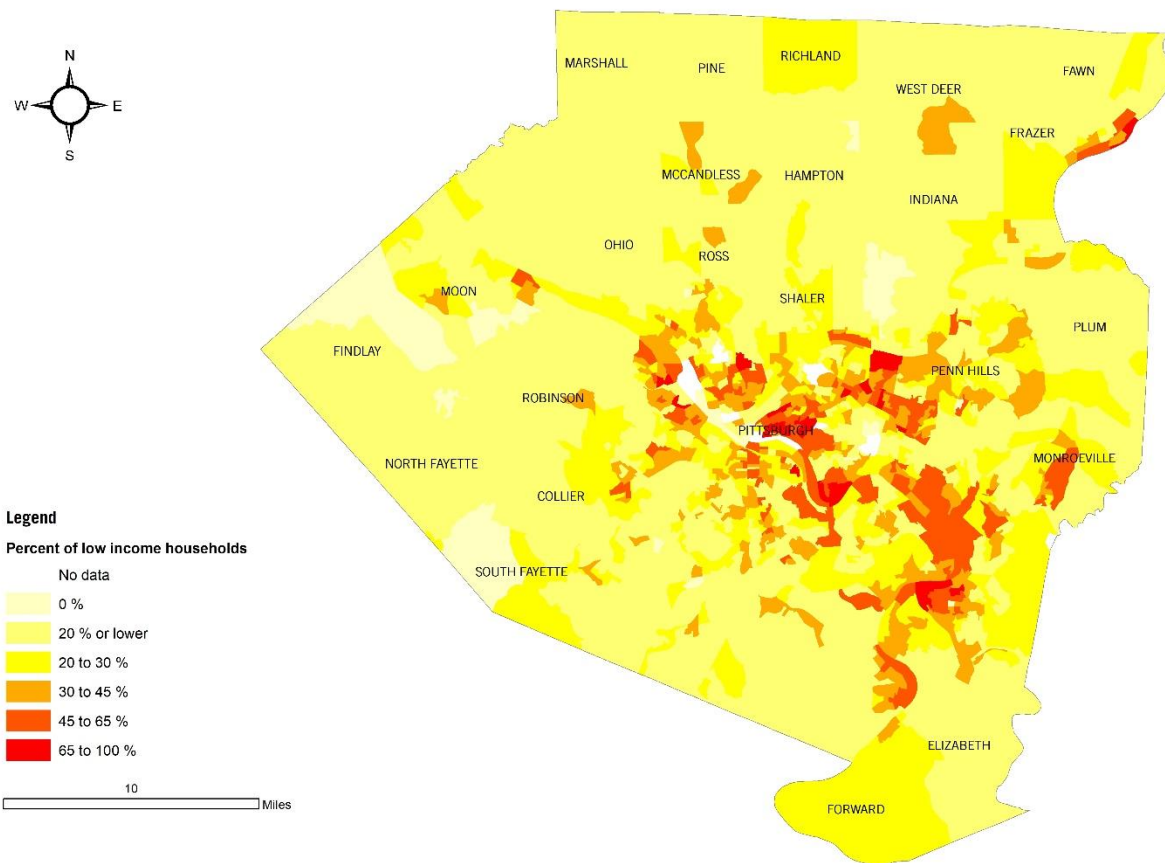


Figure 4: Map showing the distribution of percent of low income households per Census block group in Allegheny County

² U.S. Department of Health and Human Services, *Poverty Guidelines*, <https://aspe.hhs.gov/poverty-guidelines> (accessed January 22, 2019)

³ United States Census Bureau, *Household Income in The Past 12 Months (In 2016 Inflation-Adjusted Dollars) (ACS 2016)*, <https://factfinder.census.gov/> (accessed August 6, 2018)

Any household paying 30% or more of their monthly income for rent are considered as the cost burdened renters.⁴ The data to identify these households taken from the US Census dataset “Gross Rent as a Percentage of Household Income in The Past 12 Months”.⁵ Household size was not taken into account due to unavailability of information. For each block group the total number of households spending 30% or more of their income for rent was calculated. Then the percent of rent burdened households among the total households in each block group was calculated. The distribution of percent of households with rent burden is shown in Figure 5.

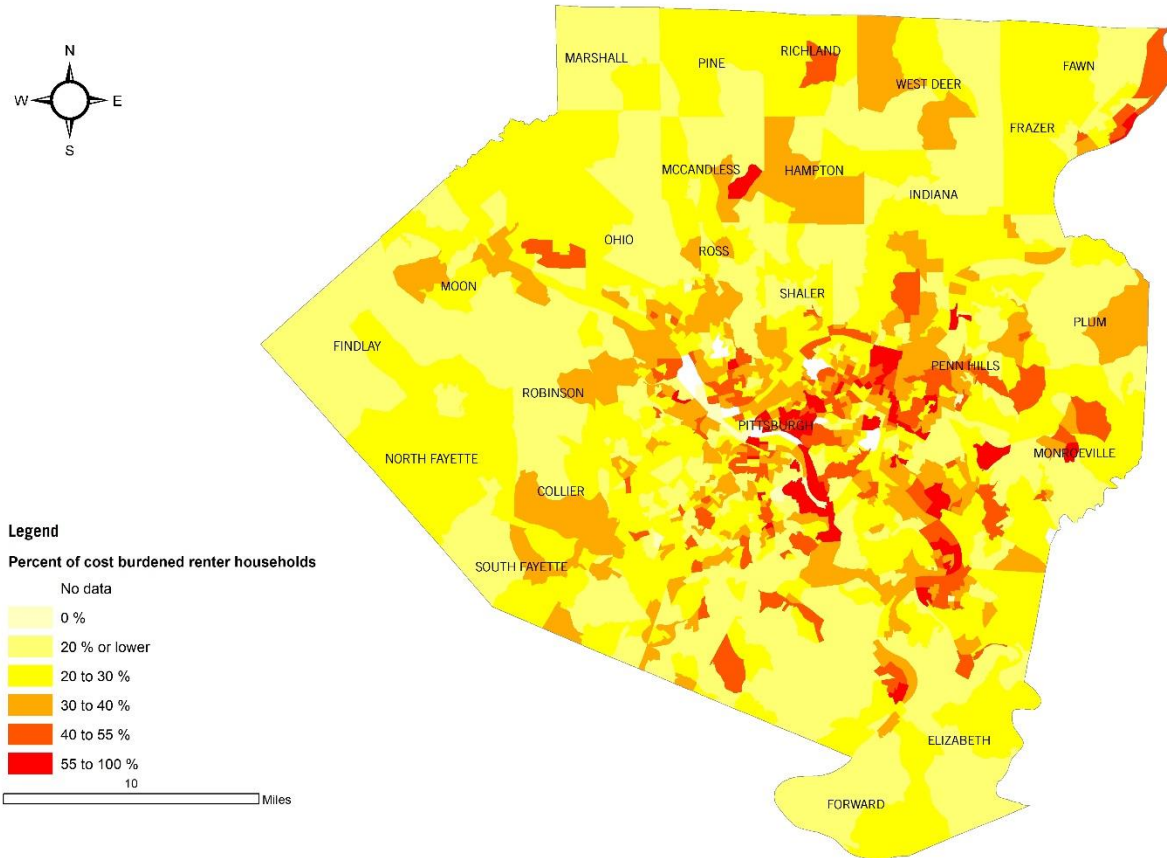


Figure 5: Map showing the distribution of percent of rent burdened households per Census block group in Allegheny County

In order to gain insight on where low income persons are working in addition to where they live, low wage job data was located from obtained from the Longitudinal Employer-Household Dynamics (LEHD) Survey, which includes the LEHD Origin-Destination Employment Statistics (LODES) data.⁶ Jobs that had a

⁴ Housing and Urban Development, *Affordable Housing*, https://www.hud.gov/program_offices/comm_planning/affordablehousing/ (accessed January 22, 2019)
⁵ United States Census Bureau, *Gross Rent as a Percentage of Household Income in The Past 12 Months (ACS 2016)*, <https://factfinder.census.gov/> (accessed August 6, 2018)
⁶ United States Census Bureau, *Longitudinal Employer-Household Dynamics Origin-Destination Employment Statistics*, <https://lehd.ces.census.gov/data/#lodes> (accessed August 6, 2018)

wage of \$1250/month (\$15k per year) or less were considered to be low income, as this was the wage bracket that most closely matched the Federal Poverty level. The relevant data for Allegheny County were found in the “pa_od_main_JT00_2015.csv” and “pa_od_aux_JT00_2015.csv” files. The ‘main’ file consists of the data for people who live and work in PA and the ‘aux’ file has the data for people who work in PA but live out of state. Together these two files give a complete picture of low wage jobs throughout the county. The details on how the appropriate data for the Allegheny County Census blocks were extracted is presented in the Appendix A. Once total jobs and the number of low income jobs in each block group were calculated, the percent of low wage jobs per Census block group was calculated. The distribution of percent of low wage jobs is shown in Figure 6.

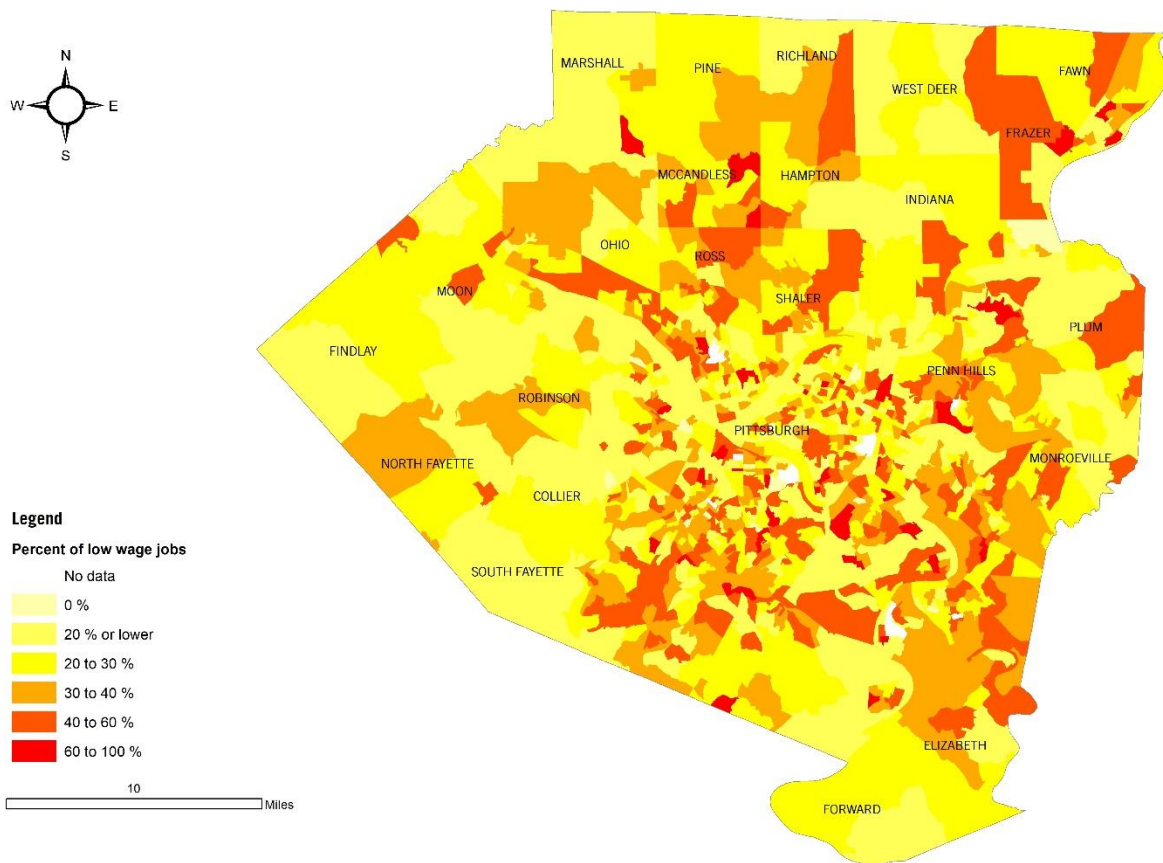


Figure 6: Map showing the distribution of percent of low wage jobs per Census block group in Allegheny County

Finally, the scores for low income jobs, cost burdened renters and low wage jobs were averaged to get a final score for poverty in each Census block group which is shown in Figure 7.

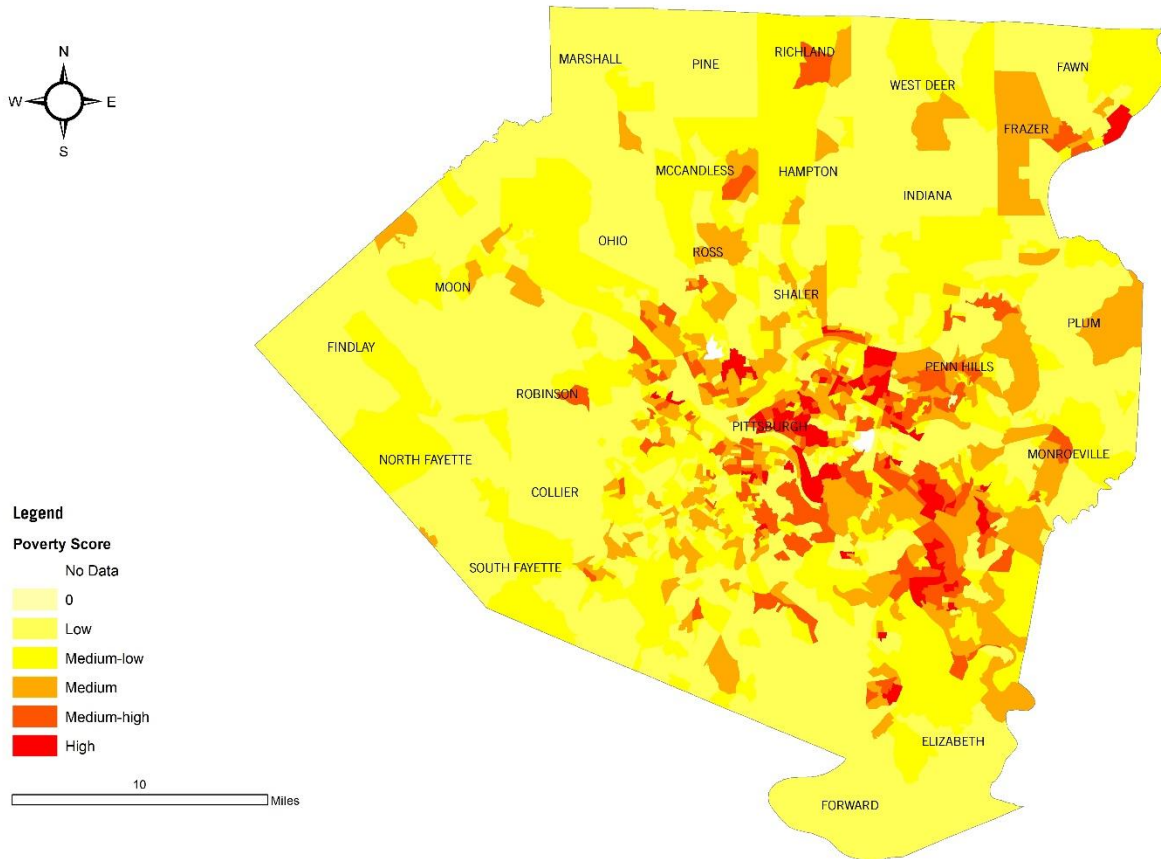


Figure 7: Map showing the distribution of poverty burdened households per Census block group in Allegheny County

3. Minority Race and Ethnicity Persons

People who are either Hispanic or do not identify as Caucasian are considered as racial and ethnic minorities.⁷ Data for minority population was found in the “Hispanic or Latino Origin by Race” dataset from the American Community Survey from the U.S. Census.⁸ All the categories of race and ethnicity except “Not Hispanic or Latino: White alone” were aggregated for each Census block group to find the total number of minorities. The distribution of racial and ethnic minority populations in Allegheny County is shown in Figure 8.

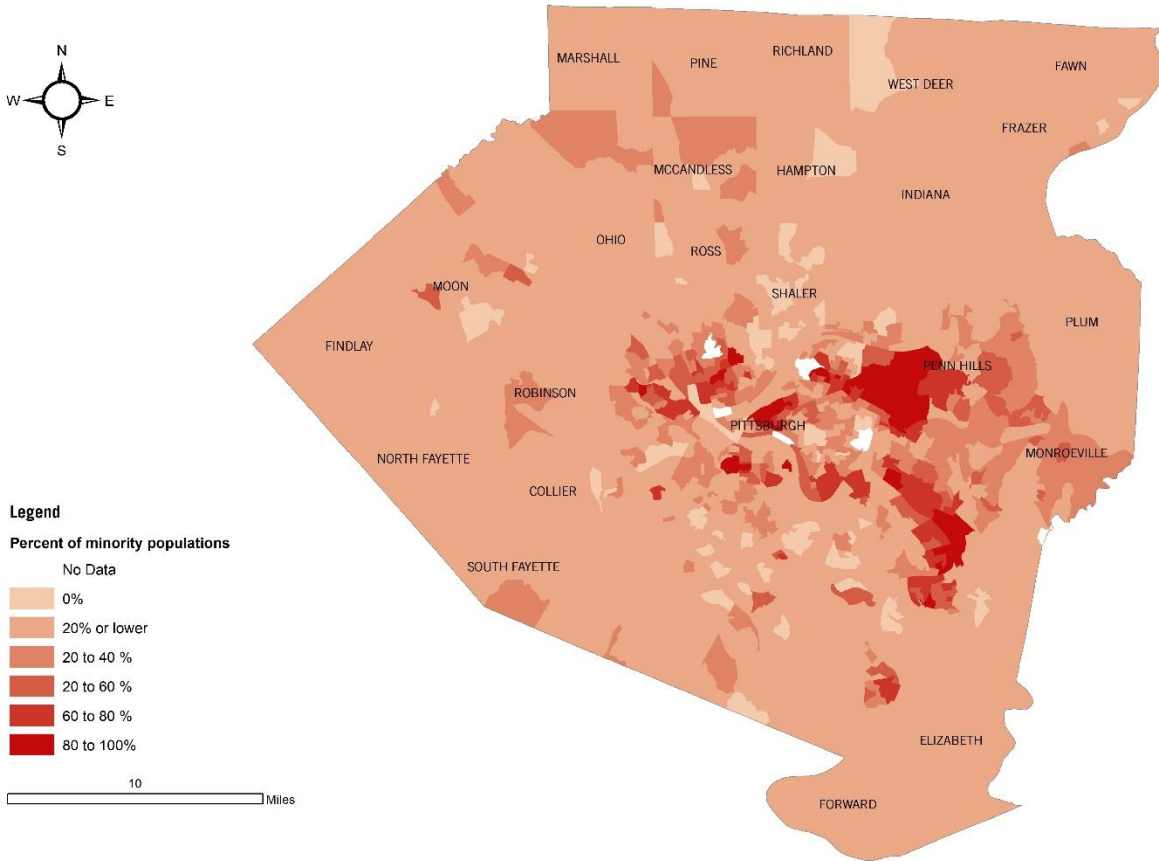


Figure 8: Map showing the distribution of percent of minority populations per Census block group in Allegheny County

⁷ Population Reference Bureau, *America’s Racial and Ethnic Minorities*, <https://www.prb.org/americasracialandethnicminorities/> (accessed January 22, 2019)

⁸ United States Census Bureau, *Hispanic or Latino Origin by Race (ACS 2016)*, <https://factfinder.census.gov/> (accessed August 6, 2018)

4. Households without Vehicles

People living in a household with no vehicle ownership. Data for household vehicle ownership was found in “Household Size by Vehicles Available” dataset on the U.S. Census.⁹ Data was not available at the Census block group level, so Census tract data was used instead. The number of households with “No vehicle available” was used here. The percentage of such households in each Census tract was calculated. All Census block group under each Census tract were given the same percent household value. Figure 9 shows the spatial distribution of households with no vehicle ownership in Allegheny County.

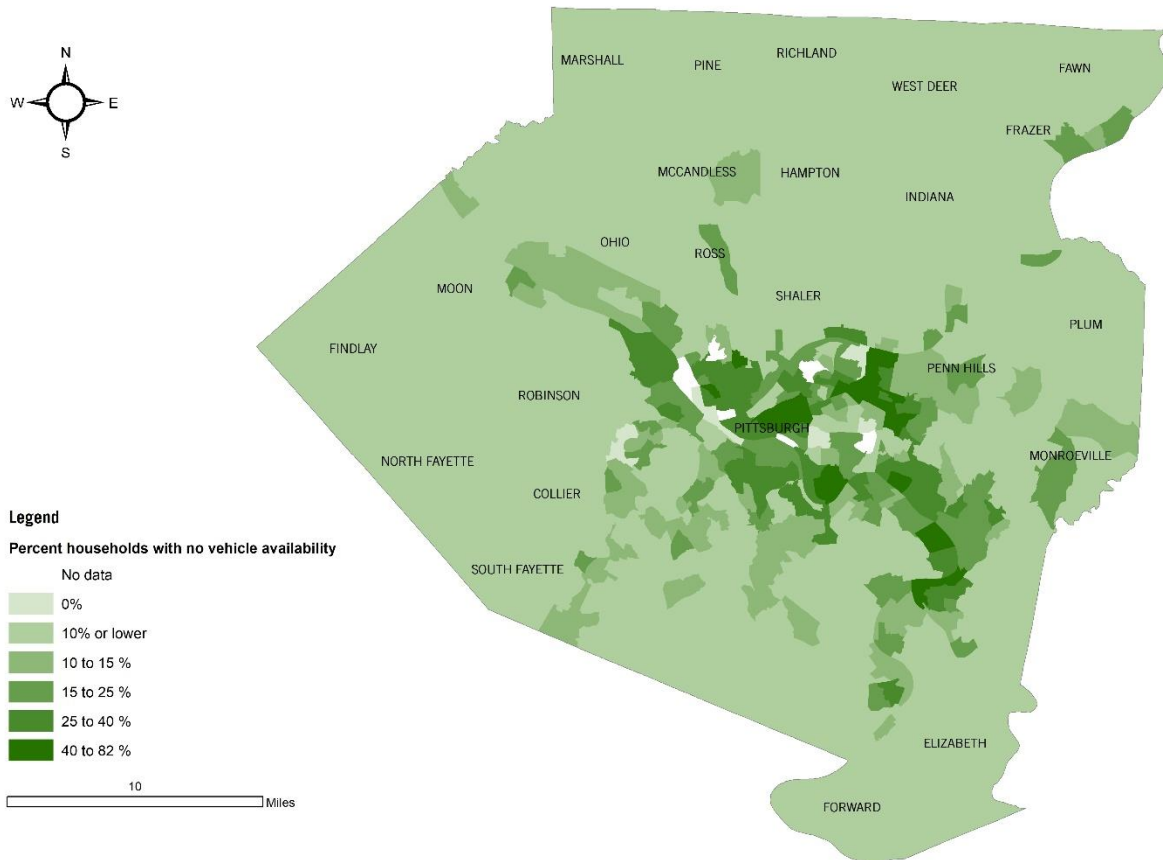


Figure 9: Map showing the distribution of percent of households with no vehicle ownership per Census tract in Allegheny County

⁹ United States Census Bureau, *Household Size by Vehicles Available (ACS 2016)*, <https://factfinder.census.gov/> (accessed August 6, 2018)

5. Older Adults

Older adults were defined as households with one or more people over age 65. Data for households with people over age 65 was used from “Households by Presence of People 65 Years and Over, Household Size and Household Type” dataset on the U.S. Census.¹⁰ Percentage of households with 1 or more people 65 years and over in each Census block group was calculated and the Census block groups were scored following the same process as the disability scores. The high score means that there are older adults in that block group [Figure 10].

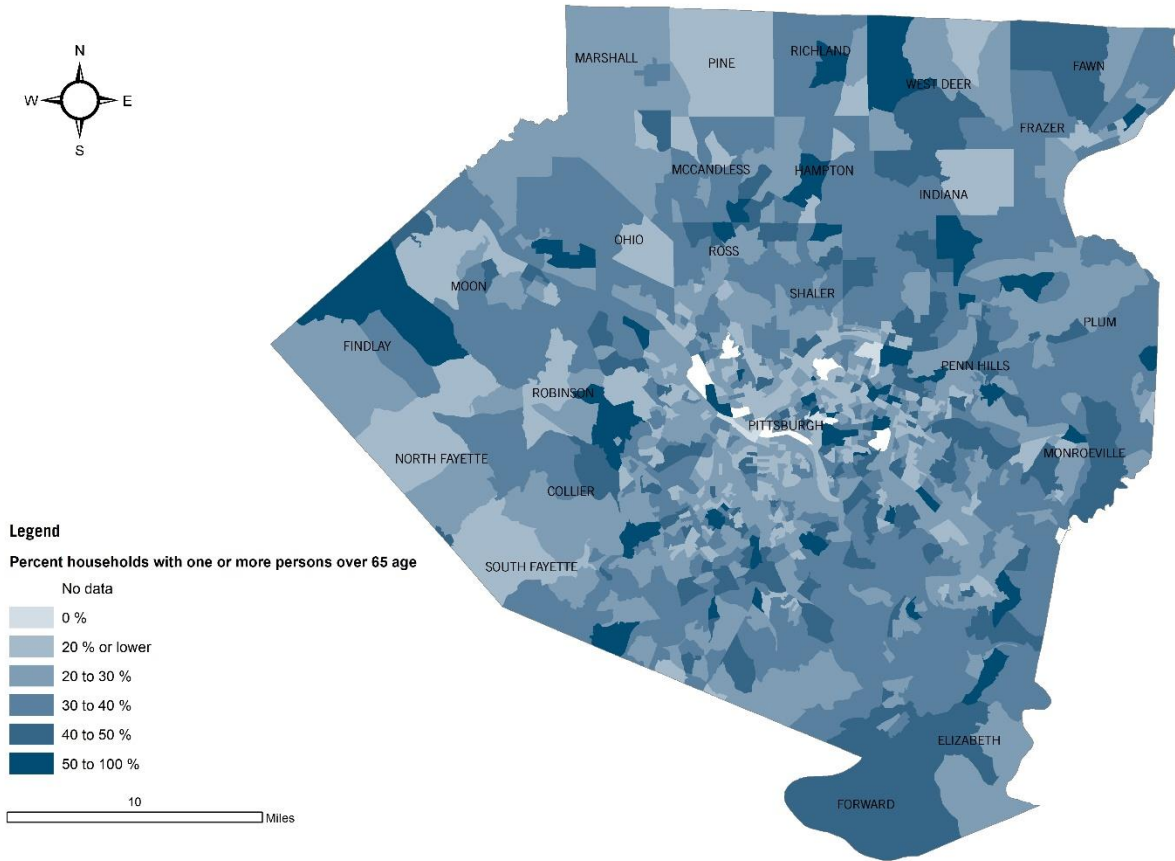


Figure 10: Map showing the distribution of percent of households with persons over 65 years per Census block group in Allegheny County

¹⁰ United States Census Bureau, *Households by Presence of People 65 Years and Over, Household Size and Household Type (ACS 2016)*, <https://factfinder.census.gov/> (accessed August 6, 2018)

6. Persons under Age 18

Households with one or more people under the age of 18 have been mapped here. Data for households with children was found in “Households by Presence of People under 18 Years by Household Type” dataset on the U.S. Census.¹¹ The percentage of households with one or more people under 18 years was calculated for each Census block group. Figure 11 shows the distribution of households with children in the county.

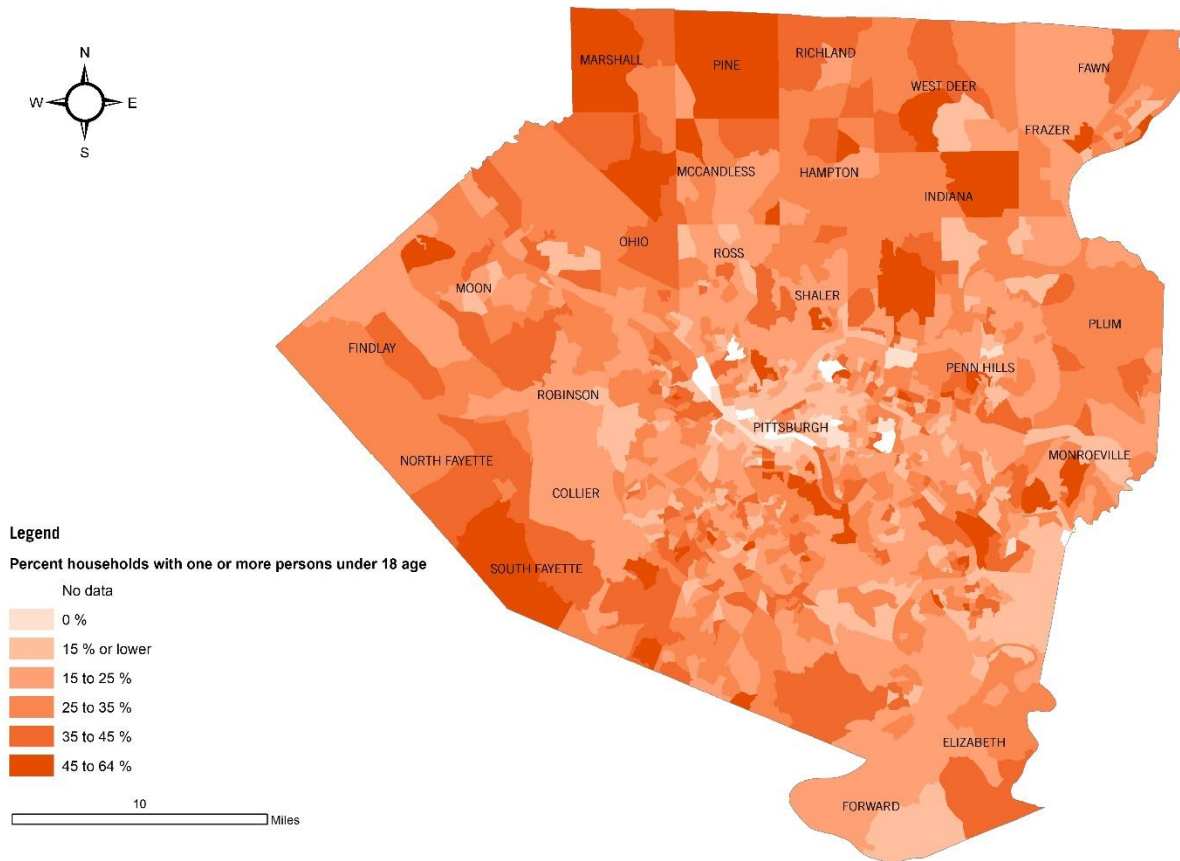


Figure 11: Map showing the distribution of percent households with persons under 18 years per Census block group in Allegheny County

¹¹ United States Census Bureau, *Households by Presence of People under 18 Years by Household Type (ACS 2016)*, <https://factfinder.census.gov/> (accessed August 6, 2018)

7. Persons with Limited English Proficiency

Households were selected where one or more persons speak a language other than English and do not report as speaking English “very well”.¹² Data for households with limited English proficiency was found in “Household Language by Household Limited English Speaking Status” dataset in the American Community Survey on the U.S. Census.¹³ All the “Limited English Speaking Households” data was aggregated per Census block group to find the total number of households with limited English proficiency. Then the percentage limited English proficiency households for each block group were calculated. Figure 12 shows the block groups where people with limited English proficiency are located.

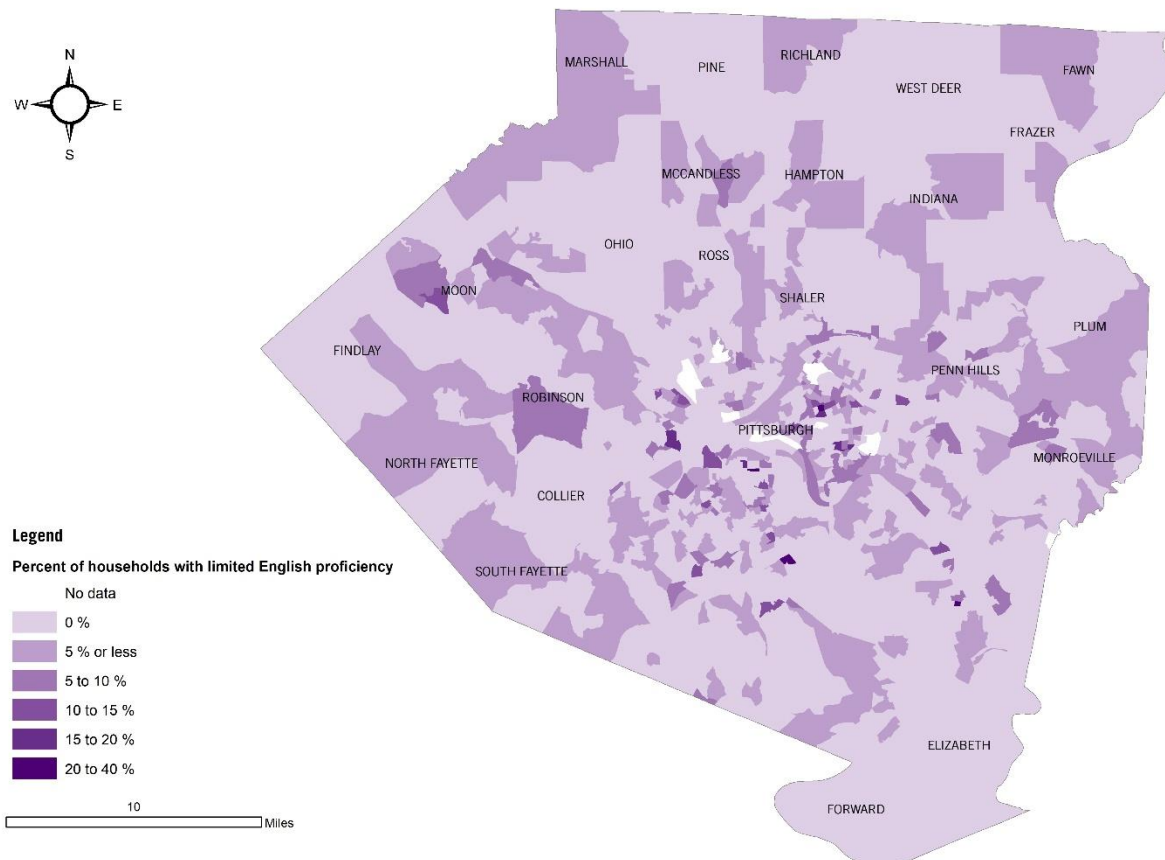


Figure 12: Map showing the distribution of percent households with persons with limited English proficiency per Census block group in Allegheny County

¹² MassLegal Services, *Resources on the Definition of LEP for Data Collection Purposes*, <https://www.masslegalservices.org/content/resources-definition-lep-data-collection-purposes> (accessed August 6, 2018)

¹³ United States Census Bureau, *Household Language by Household Limited English Speaking Status (ACS 2016)*, <https://factfinder.census.gov/> (accessed August 6, 2018)

8. Female Householders

Households which is a family with children and with no husband present. Family data was obtained from the US Census. The data for “Poverty Status in The Past 12 Months of Families by Family Type by Presence of Related Children Under 18 Years by Age of Related Children” was used.¹⁴ The number of households in the columns for ‘Female householder, no husband present’ were summed for each block group. The percentage of single mother households among the total households in each block group was calculated. Figure 13 shows the spatial distribution of single female headed households in Allegheny county.

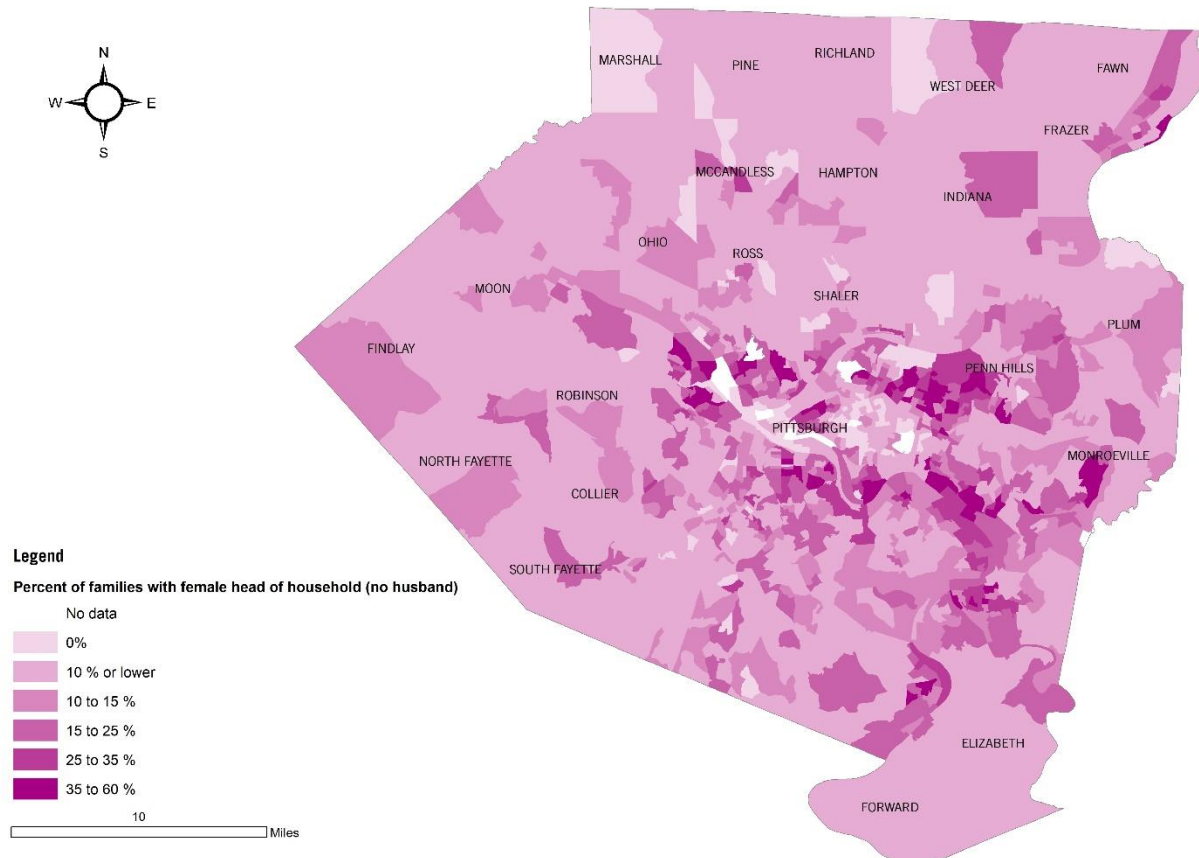


Figure 13: Map showing the distribution of percent of single female headed households per Census block group in Allegheny County

¹⁴ United States Census Bureau, *Poverty Status in The Past 12 Months of Families by Family Type by Presence of Related Children Under 18 Years by Age of Related Children (ACS 2016)*, <https://factfinder.census.gov/> (accessed August 6, 2018)

Final Equity Index of Mobility Need

In the previous steps each of the 8 factors was given a score of ranging from 0-1. This allows for each to be on an equal platform to be averaged for a final score. Finally, for each Census block group all 8 scores were averaged into one final score which is the “Equity Index Score” for Allegheny County.

Figure 14 shows the final Equity Index for mobility. Here the dark red shows higher mobility need areas and as it gets more green it means lesser mobility need.

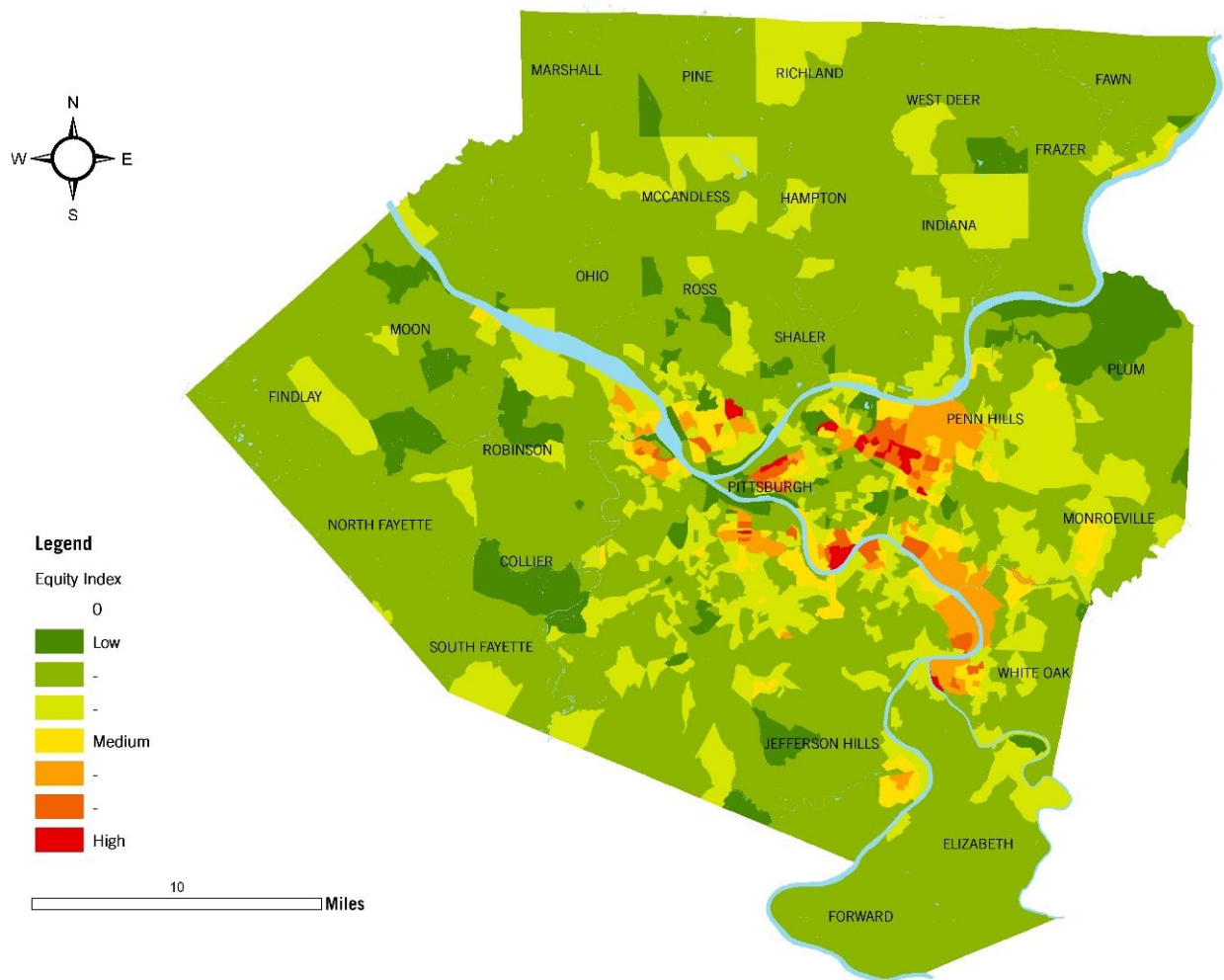


Figure 14: Map showing the Equity Index for Block Groups in Allegheny County, PA.

Equity in the Municipalities of Allegheny County and Neighborhoods in Pittsburgh

The equity index can also be aggregated across municipalities to indicate areas of high mobility need by municipality. To accomplish this a spatial join was performed in ArcGIS joining municipal boundaries and the Equity Index by block group layers. The scores of each block group were then averaged within each municipality. Municipalities with the highest equity scores are identified in Table 2. The full list can be found in Appendix B. The distribution of municipality equity scores can be seen in Figure 15.

Table 2: Highest equity municipalities in Allegheny County

Top ten (Highest Mobility Need) Municipalities

Braddock Borough

Rankin Borough

Homestead Borough

Mount Oliver Borough

North Braddock Borough

City of Duquesne

West Homestead Borough

East Pittsburgh Borough

Wilkesburg Borough

City of McKeesport

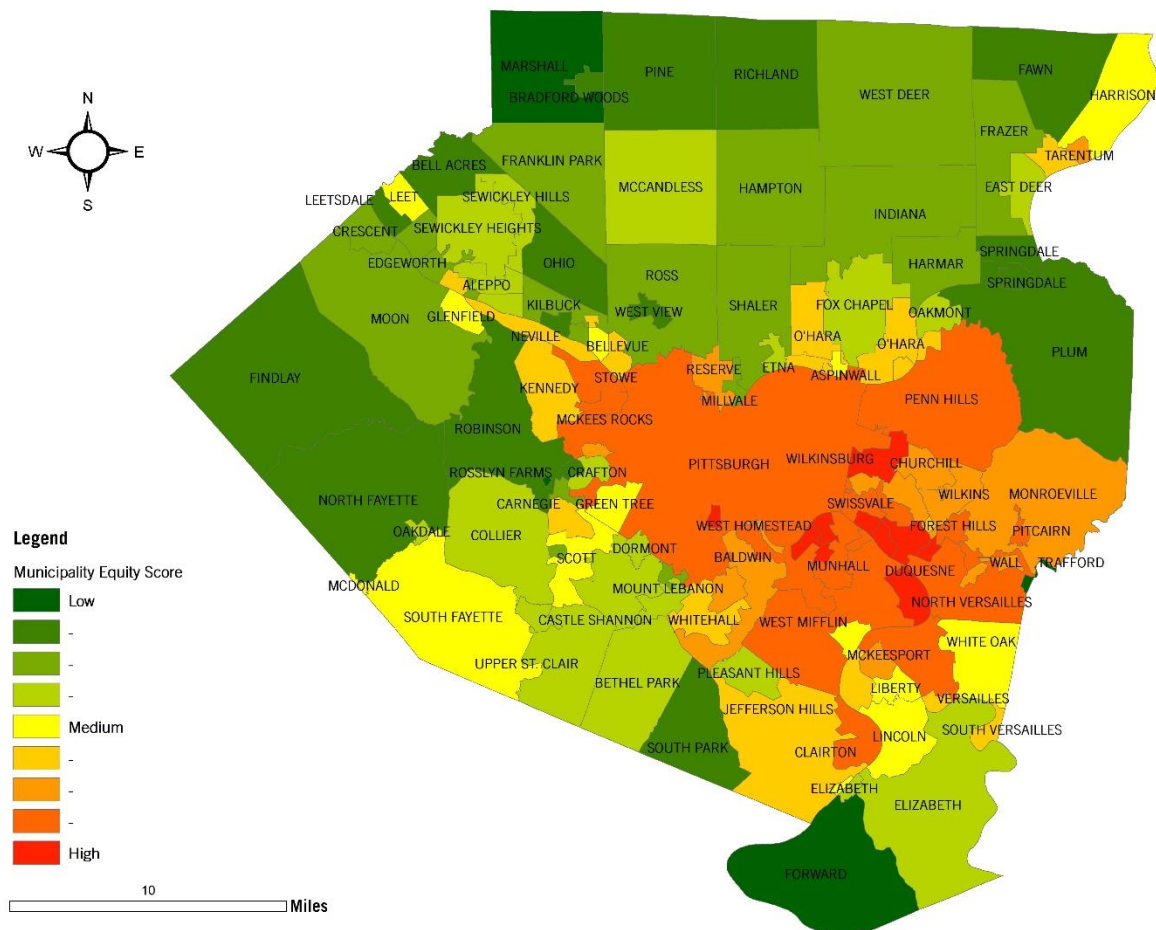


Figure 15: Map showing the equity scores of the Municipalities of Allegheny County

Further analysis was performed in order to see the variation of equity inside the City of Pittsburgh, since it is the largest municipality in Allegheny County. The following map was prepared by performing a one-to-many spatial join (by centroid) of the Census block groups with the neighborhoods in ArcGIS. Then the equity scores of the block groups in each neighborhood were aggregated and averaged to get a score for each City neighborhood. Neighborhoods with the highest equity scores are identified in Table 3. The full list can be found in Appendix B. The equity score for each City neighborhood can be seen in Figure 16.

Table 3: Highest equity neighborhoods in Allegheny County

Top ten (Highest Equity) Neighborhoods

- Northview Heights
- Bedford Dwellings
- Homewood North
- Glen Hazel
- Larimer
- Homewood West
- Crawford-Roberts
- Homewood South
- Arlington Heights
- Middle Hill

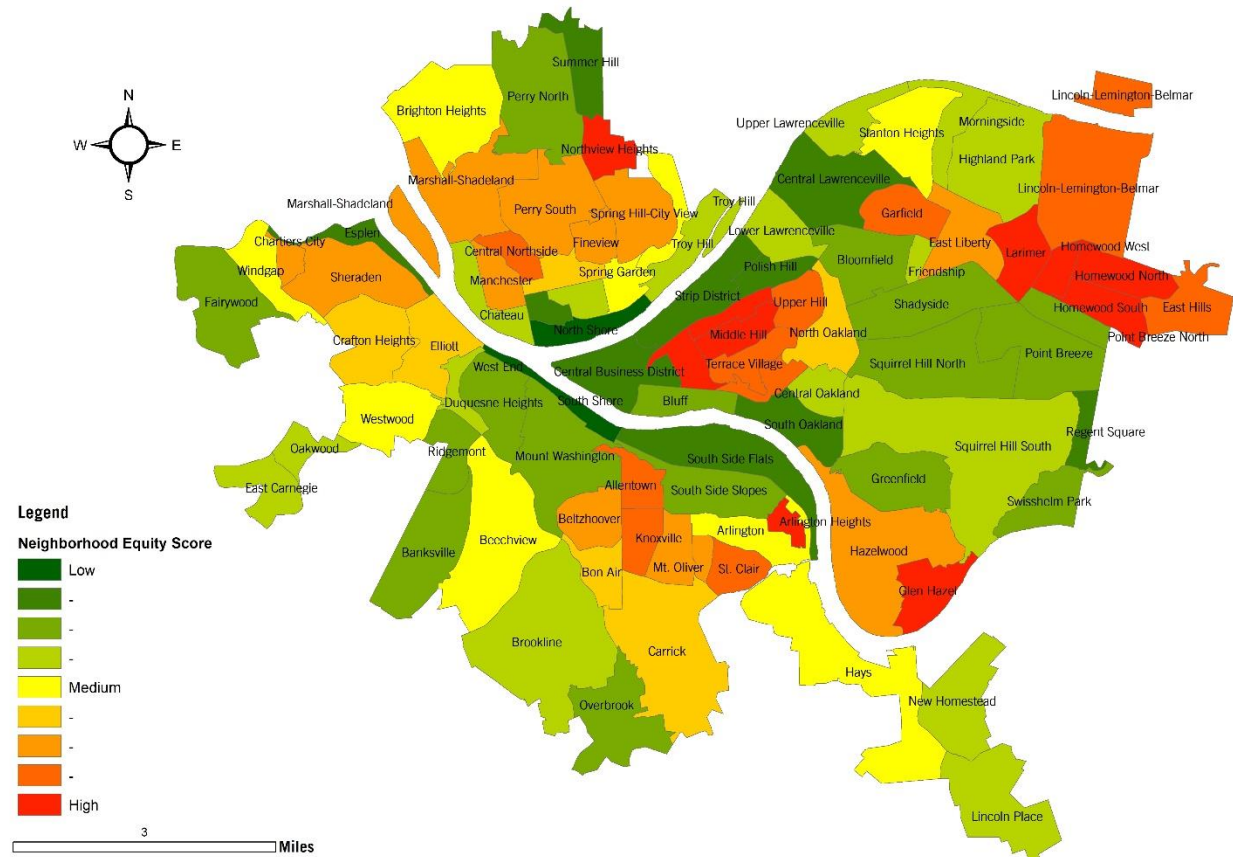


Figure 16: Map showing the equity scores in neighborhoods in the City of Pittsburgh

Transit Service in Municipalities and Neighborhoods

It is important to note areas of high mobility needs that do not have any access to transit service as a way of prioritizing future areas that the Authority may wish to provide transit service. To do this, municipalities with no transit stops were identified using a spatial join between the municipality equity score layer and the PAAC transit stops layer [Figure 18].

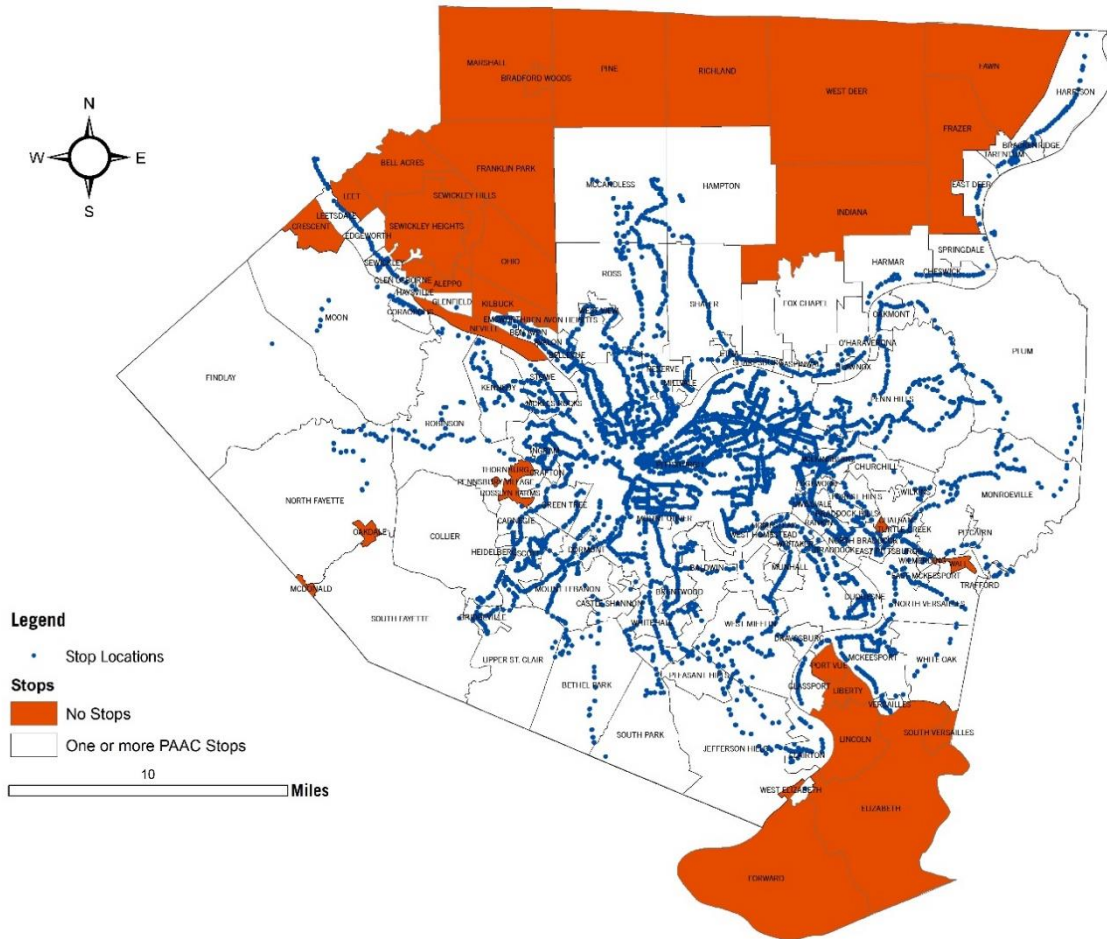


Figure 17: Map showing the municipalities with no transit service (in red)

Table 4 shows the top ten highest equity areas with no transit stops. The highest ranked municipality without any transit service is Wall Borough with a mobility rank of 26th. This means that the Authority is serving the 25 highest mobility need municipalities today. A full list can be found in Appendix C.

Table 4: Equity rank of municipalities with no transit service.

Municipality Name	Equity Rank
Wall Borough	26
Port Vue Borough	28
Chalfant Borough	41
Neville Township	48
Ben Avon Heights Borough	49
South Versailles Township	51
McDonald Borough	56
Liberty Borough	61
West Elizabeth Borough	63
Lincoln Borough	65

The neighborhoods in Pittsburgh were also overlaid with the stops to see if any City of Pittsburgh neighborhoods did not have transit. The only 2 neighborhoods were found not to have any transit service; Arlington Heights and Ridgemont [Figure 19].

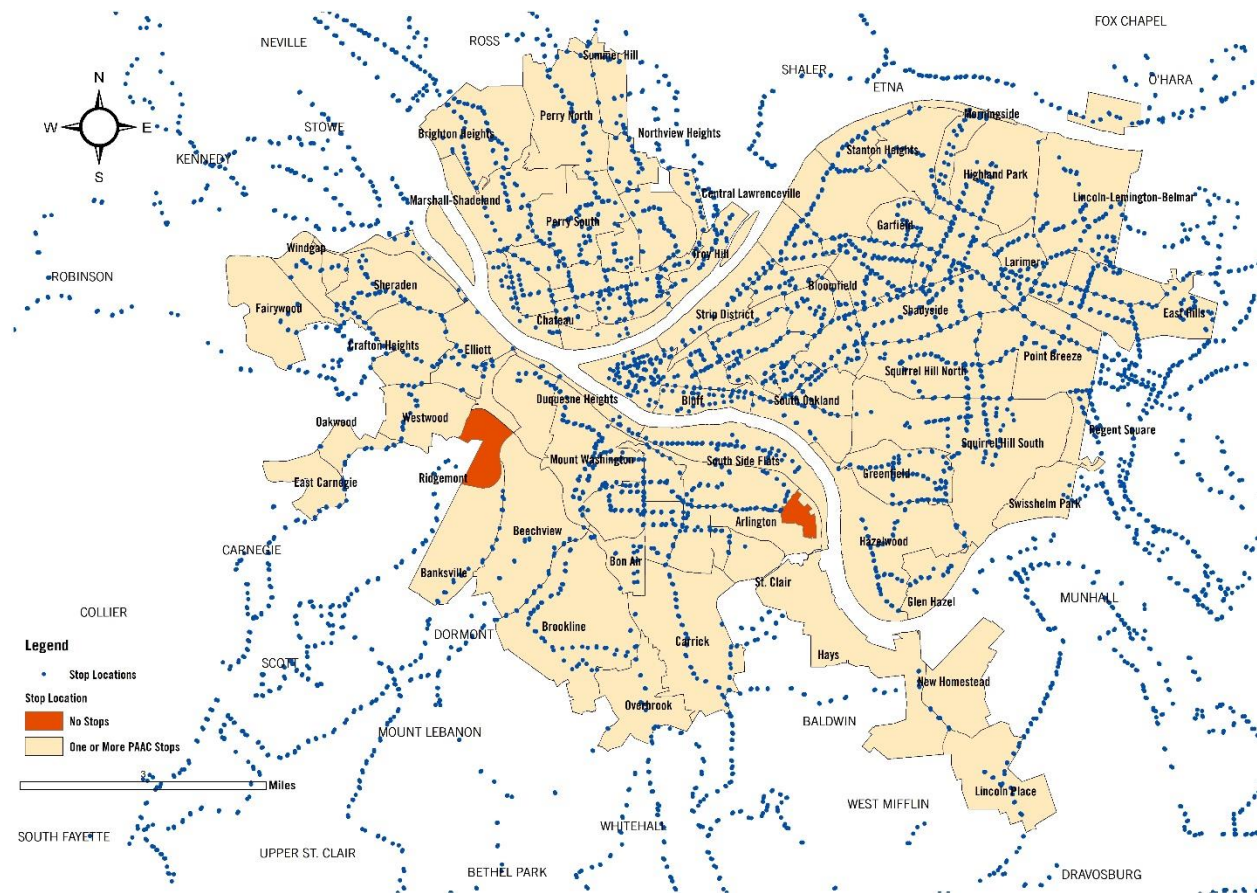


Figure 18: Map showing the neighborhoods with no transit service (in red)

In addition to understanding where high mobility need areas are, it is worth looking at the availability of frequent transit in these areas. Frequent transit is defined as having bus service every fifteen minutes. It is important for populations with high mobility needs to have access to frequent transit because they are dependent on the transit service for their mobility beyond just commuting to and from work.

To look at this, Port Authority’s frequent transit service layer was overlaid on top of the municipal and the neighborhood equity scores layers in ArcGIS (see Figure 17 below). A select by location was then performed, that selected the areas that intersected with the frequent transit service layer. By doing a ‘switch selection’ in the attribute Table the areas with no frequent service were selected and then copied into excel to find the top equity areas. The list of the top ten areas of highest mobility need that do not have frequent transit includes Arlington Heights (City of Pittsburgh neighborhood, equity rank of #9) St. Clair (City of Pittsburgh neighborhood, equity rank of #12) and Mt. Oliver (City of Pittsburgh neighborhood, equity rank of #25). See Table 4 for the top 10 list and Appendix D for the full list of neighborhoods or municipalities with no frequent transit.

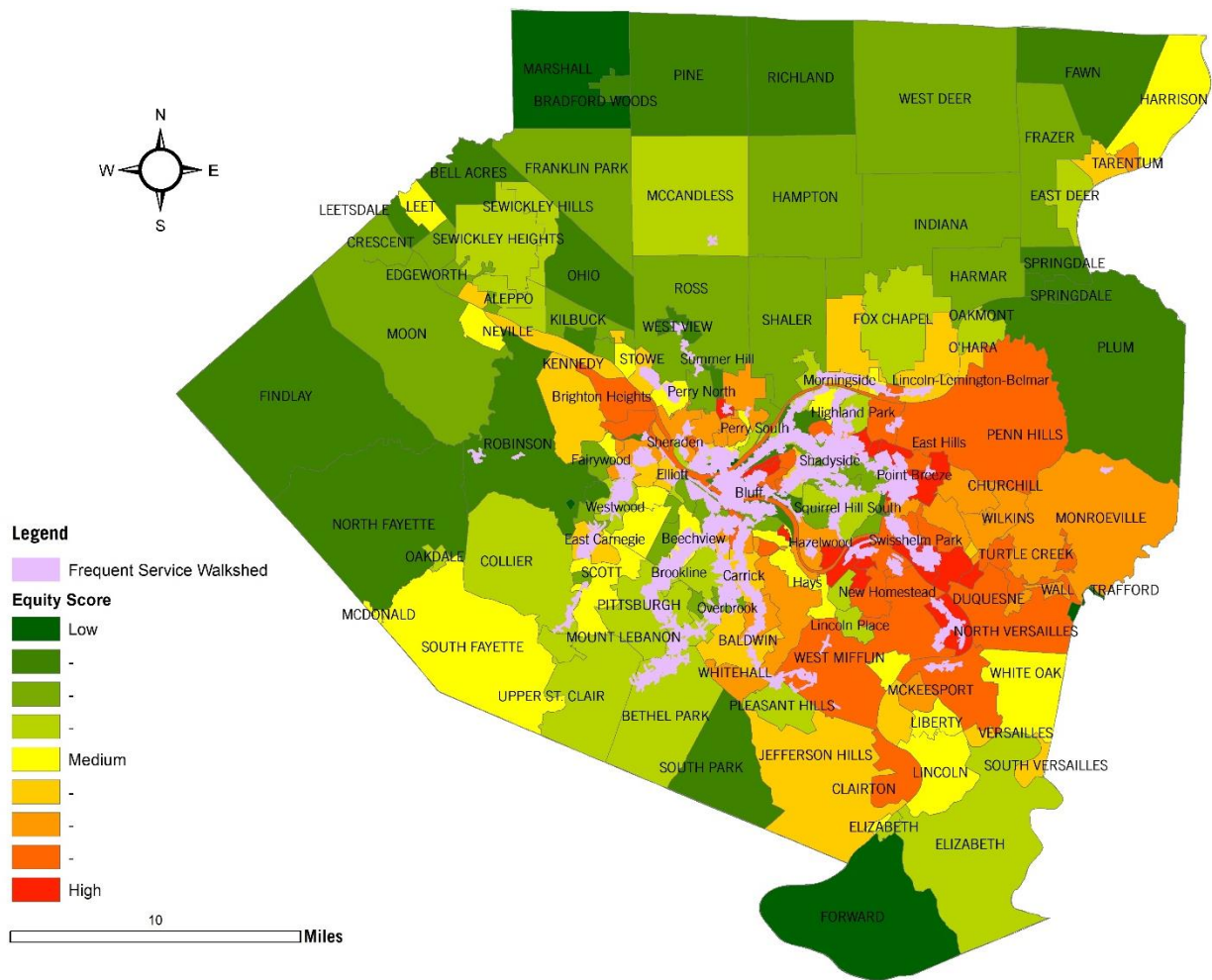


Figure 19: Map showing frequent transit service in high equity areas

Table 5: Equity rank of places (municipality or neighborhood) with no frequent transit.

Place name	Area	Rank
Arlington Heights	Neighborhood	9 th
St. Clair	Neighborhood	12 th
Mt. Oliver	Neighborhood	25 th
Spring Hill-City View	Neighborhood	26 th
Chartiers City	Neighborhood	33 th
East Pittsburgh Borough	Municipality	40 th
Pitcairn Borough	Municipality	52 th
Turtle Creek Borough	Municipality	54 th
North Versailles Township	Municipality	55 th
Stowe Township	Municipality	58 th

Equity of transit routes

The overall equity of each transit route can be analyzed from the block group data. To find this a ‘one to many’ spatial join was performed with the routes and intersecting block groups. Then the joined information was aggregated by route and averaged to get an equity score for each route. The higher average equity score here means that route provides service to relatively higher mobility areas than the other routes. The top ten transit routes serving high equity areas can be seen below in Table 6; the full Table can be found in Appendix E.

Table 6: Equity score for transit routes

Route	Average Equity Score	Rank
79	0.380	1
89	0.332	2
60	0.320	3
82	0.313	4
74	0.312	5
86	0.302	6
P7	0.299	7
P17	0.297	8
P3	0.287	9
59	0.284	10

Conclusion

The 2019 Port Authority of Allegheny County Equity Index provides insight into the higher mobility need areas of the county. It includes data for locations with people in poverty, racial and ethnic minorities, people with disabilities, households with older adults or people under 18, people with limited English proficiency, households with no vehicle ownership and female householder families. These are some demographics are known to have higher mobility needs. So together they are a reliable indicator for prioritizing places that might be in need of public transit. Overlaying the Allegheny county municipalities and the City of Pittsburgh neighborhoods with this index helped to identify these places of priority. The equity index also helped find which higher mobility need area in the county does not have frequent transit service or maybe no transit service at all. Finally, the index was used see which PAAC routes go through areas of higher mobility need. This could help possible future changes in making small routing changes to include high equity areas that are near current service areas – that would help the PAAC serve the community better and also improve the ridership.

The next steps with the information presented in this report is to have a more detailed look into the transportation scenario of the county. Looking at higher mobility need at a block group level might allow PAAC to focus on smaller areas to prioritize extension or expansion of service. Another next step could be to look at the various micro-transit operators in the county – the areas they operate and the ridership they have. This could help to pave a path towards building more ridership for PAAC's fixed route services. The index could also help to guide any change in the PAAC service to connect people to job locations.

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Appendix A

The data used here was obtained from the US Census Bureau website- where the data for low wage jobs was from Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) 2015 dataset¹⁵, and the data for low income households, minority race and ethnicity populations, Households with persons over age 65, Households with persons under age 18, persons with disabilities, households with available vehicle, households with limited English proficiency and families with single mothers was obtained from American Community Survey (ACS) 2016 dataset¹⁶. The data for ACCESS paratransit trips was obtained from ACCESS.

Persons without access to vehicles

To find the Census tract a Census block group is in, this methodology can be followed:

- In a blank column next to the Block group ID column, insert the =LEFT(A2, 12) function in excel. This will give us the 11-digit Census tract number.
- Then the values for percent household in each Census tract can be distributed to the block groups using the vlookup function.

Low wage jobs

- First set the categories for the LODES7, Pennsylvania, Origin-Destination (OD) data on <https://lehd.ces.census.gov/data/#lodes> page.
- After clicking view files, scroll down to “pa_od_main_JT00_2015.csv” and “pa_od_aux_JT00_2015.csv” and download them.
- The file name gives the indication of what information it has (for further detail you can download one of the “LODESTechDoc” documents from website):
 - State= pa
 - File type = od
 - Person characteristics = ‘main’ is for people who live and work in the state, ‘aux’ is for people who live outside state and work in the state. To ensure we have all the low wage jobs mapped we have used both files.
 - Job type= “JT” varies 00 through 05, where 00 is all jobs, that is why we are using that.
 - Year= is the year of the data, and 2015 is the latest.
- After downloading the stated files, look at the column headers.
 - For obtaining low wage job locations, we need the “w_geocode” which is the geo location of the workplaces.
 - “SE” columns have the numbers of jobs. For our Equity Index we have used numbers from SE01.
 - SE01 are Number of jobs with earnings \$1250/month or less
 - SE02 are Number of jobs with earnings \$1251/month to \$3333/month
 - SE03 are Number of jobs with earnings \$3333/month more more.
- This file contains all the Census block in the state of Pennsylvania. The ‘w-geocode’ has 15 digits representing each Census block in the state, where-

¹⁵ United states Census Bureau, *Longitudinal Employer-Household Dynamics Origin-Destination Employment Statistics*, <https://lehd.ces.census.gov/data/#lodes> (accessed August 6, 2018)

¹⁶ United states Census Bureau, *American Community Survey (ACS) 2016*, <https://factfinder.census.gov/> (accessed August 6, 2018)

- First 2 digits represent the state (42)
- Next 3 digits represent the county, which for Allegheny county is 003.
- The next 6 digits represent the Census tract.
- The next 1 digit represents the block group
- And finally, the last 3 digits are for the block.

So in this step separate all the block groups that have “42003”.

- Once all the Allegheny county blocks are obtained the next step is to get the block group ID in a separate column. The first 12 digits in this number represents the Census Block Group of the job location. So the next step was to create a column in the Table and use the =LEFT(A2, 12) function in excel to find the respective block group ID. This needs to be done for both main and aux files.
- The next step is to summarize the Table using the pivot Table function. The Block group ID will be in rows, and SE01, SE02 and SE03 in values to get the sums of the number of jobs in each block group. This needs to be done for both main and aux files, so that the total number of jobs for each type is known.
- The next step would be to copy both Tables as one Table in a separate sheet and create another pivot Table to get the sum of main and aux jobs by block group. A simple addition with vlookup, would not work here as all the main and aux block groups are not same and might have missed some data.
- This will give the final Table with the number of jobs for each block group in three earning groups.

Appendix B

Equity Index of municipalities (highest to lowest)

Municipality	Equity Index
Braddock Borough	0.36822
Rankin Borough	0.338727
Homestead Borough	0.331134
Mount Oliver Borough	0.327933
North Braddock Borough	0.322351
Duquesne	0.312221
West Homestead Borough	0.297418
East Pittsburgh Borough	0.291135
Wilkesburg Borough	0.290192
McKeesport	0.270974
Whitaker Borough	0.263331
Penn Hills Municipality	0.261491
Swissvale Borough	0.253578
McKees Rocks Borough	0.250342
Pitcairn Borough	0.249893
Turtle Creek Borough	0.246108
North Versailles Township	0.244666
Pittsburgh	0.244125
Braddock Hills Borough	0.243211
Stowe Township	0.240182
Wilmerding Borough	0.235949
Clairton	0.235859
West Mifflin Borough	0.235579
Munhall Borough	0.233755
Brentwood Borough	0.228653
Wall Borough	0.225293
Edgewood Borough	0.223033
Port Vue Borough	0.222909
Brackenridge Borough	0.222784
Ingram Borough	0.219264
Churchill Borough	0.216403
East McKeesport Borough	0.216196
Reserve Township	0.216001
Monroeville Municipality	0.215512
Baldwin Borough	0.215395
Wilkins Township	0.212911
Forest Hills Borough	0.212168
Blawnox Borough	0.206467
Kennedy Township	0.202418
Tarentum Borough	0.202059
Chalfant Borough	0.201821

Versailles Borough	0.200603
Whitehall Borough	0.200295
O Hara Township	0.199766
Verona Borough	0.199623
Glen Osborne Borough	0.199371
Carnegie Borough	0.19911
Neville Township	0.197356
Ben Avon Heights Borough	0.197056
Sharpsburg Borough	0.196722
South Versailles Township	0.196641
Glassport Borough	0.196203
Bellevue Borough	0.195914
Jefferson Hills Borough	0.195693
Coraopolis Borough	0.193259
McDonald Borough	0.192863
Harrison Township	0.192532
Dravosburg Borough	0.192503
Avalon Borough	0.191601
Aspinwall Borough	0.191528
Liberty Borough	0.191438
Scott Township	0.191094
West Elizabeth Borough	0.190796
Green Tree Borough	0.190125
Lincoln Borough	0.18981
White Oak Borough	0.188994
South Fayette Township	0.188387
Leet Township	0.187594
Pleasant Hills Borough	0.184512
Bethel Park Municipality	0.184125
McCandless Township	0.183922
Elizabeth Borough	0.183616
Dormont Borough	0.183547
Fox Chapel Borough	0.183427
Bridgeville Borough	0.183312
Upper St. Clair Municipality	0.182775
Aleppo Township	0.18252
Etna Borough	0.181933
Castle Shannon Borough	0.181769
Crafton Borough	0.181662
Elizabeth Township	0.181558
East Deer Township	0.180556
Sewickley Heights Borough	0.180382
Oakdale Borough	0.180151
Mount Lebanon	0.180114
Sewickley Hills Borough	0.179562
Oakmont Borough	0.17949

Glenfield Borough	0.179433
Collier Township	0.179254
Sewickley Borough	0.177469
Hampton Township	0.176696
Baldwin Township	0.176536
Moon Township	0.175952
Indiana Township	0.17577
Kilbuck Township	0.17469
Shaler Township	0.174612
Harmar Township	0.174128
Franklin Park Borough	0.173972
West Deer Township	0.173423
Ben Avon Borough	0.173334
Haysville Borough	0.173061
Crescent Township	0.172948
Frazer Township	0.172149
Edgeworth Borough	0.171987
Heidelberg Borough	0.171313
Millvale Borough	0.171063
Ross Township	0.17055
Rosslyn Farms Borough	0.167343
Robinson Township	0.165191
Springdale Township	0.164632
Emsworth Borough	0.164407
Ohio Township	0.164226
Plum Borough	0.163451
Cheswick Borough	0.162564
Richland Township	0.162441
South Park Township	0.160658
Bradford Woods Borough	0.158568
Pine Township	0.157464
West View Borough	0.156658
Fawn Township	0.155894
Thornburg Borough	0.155595
North Fayette Township	0.155357
Bell Acres Borough	0.152315
Leetsdale Borough	0.151988
Springdale Borough	0.151968
Findlay Township	0.150849
Marshall Township	0.139158
Forward Township	0.136789
Trafford Borough	0.135186
Pennsbury Village Borough	0.132054

Equity Index of neighborhoods (highest to lowest)

Neighborhood	Equity Index
Northview Heights	0.544218
Bedford Dwellings	0.51453
Homewood North	0.5021844
Glen Hazel	0.48223
Larimer	0.46861275
Homewood West	0.4664335
Crawford-Roberts	0.461551
Homewood South	0.459634833
Arlington Heights	0.44952
Middle Hill	0.445813667
California-Kirkbride	0.415621
St. Clair	0.406604
Allentown	0.402797333
Garfield	0.3849084
West Oakland	0.384125
Knoxville	0.382331167
Upper Hill	0.381464
East Hills	0.377551667
Terrace Village	0.37485925
Lincoln-Lemington-Belmar	0.3627465
East Liberty	0.357098125
Mount Oliver Borough	0.35087275
Beltzhoover	0.34606175
Mt. Oliver	0.345792
Spring Hill-City View	0.341594333
Hazelwood	0.340547
Marshall-Shadeland	0.32619025
Chartiers City	0.321992
Sheraden	0.315140429
Perry South	0.3142335
Fineview	0.309562
Manchester	0.3067985
Elliott	0.274250667
Crafton Heights	0.26969175
Bon Air	0.263533
North Oakland	0.2620015
Central Northside	0.261976
Grand Total	0.251439931
Carrick	0.248458692
Spring Garden	0.244509
Stanton Heights	0.238555
Hays	0.237169
Arlington	0.231504
East Allegheny	0.231079

Windgap	0.2282055
Beechview	0.2256131
Brighton Heights	0.224010571
Westwood	0.218494
Lower Lawrenceville	0.2139465
Oakwood	0.210719
Morningside	0.208472
Allegheny Center	0.207637
Brookline	0.205545688
Lincoln Place	0.205119
New Homestead	0.204814
Friendship	0.2018195
Troy Hill	0.2016545
Chateau	0.201444
Upper Lawrenceville	0.200381
East Carnegie	0.200296
Central Oakland	0.195388
Squirrel Hill South	0.194965923
Highland Park	0.1935865
Overbrook	0.1900216
Point Breeze	0.188594714
Ridgemont	0.185847
Shadyside	0.185169857
Fairywood	0.182444
Point Breeze North	0.179265333
Greenfield	0.178864222
Perry North	0.178271333
Mount Washington	0.176794222
Bloomfield	0.1767266
South Side Slopes	0.176439143
Squirrel Hill North	0.1758388
Swisshelm Park	0.17261
Bluff	0.1708115
Duquesne Heights	0.170279
Banksville	0.16748175
Polish Hill	0.1578545
Regent Square	0.157302
Central Lawrenceville	0.154667
South Oakland	0.14810075
Central Business District	0.147176167
Strip District	0.144228
Summer Hill	0.140638
Allegheny West	0.12987
South Side Flats	0.129184167
North Shore	0.0675445
South Shore	0.010445

Appendix C

Equity rank of municipalities according to number of stops present (lowest to highest)

Municipality Name	Equity Rank
Wall Borough	26
Port Vue Borough	28
Chalfant Borough	41
Neville Township	48
Ben Avon Heights Borough	49
South Versailles Township	51
McDonald Borough	56
Liberty Borough	61
West Elizabeth Borough	63
Lincoln Borough	65
Leet Township	68
Aleppo Township	77
Elizabeth Township	81
Sewickley Heights Borough	83
Oakdale Borough	84
Sewickley Hills Borough	86
Indiana Township	94
Kilbuck Township	95
Franklin Park Borough	98
West Deer Township	99
Crescent Township	102
Frazer Township	103
Rosslyn Farms Borough	108
Ohio Township	112
Richland Township	115
Bradford Woods Borough	117
Pine Township	118
Fawn Township	120
Thornburg Borough	121
Bell Acres Borough	123
Marshall Township	127
Forward Township	128
Pennsbury Village Borough	130
South Fayette Township	67
Elizabeth Borough	72
Fox Chapel Borough	74
Baldwin Township	92
Haysville Borough	101
Glenfield Borough	88
Trafford Borough	129

West Homestead Borough	7
Springdale Township	110
Findlay Township	126
Pitcairn Borough	15
East McKeesport Borough	32
Verona Borough	45
Upper St. Clair Municipality	76
Dravosburg Borough	58
Aspinwall Borough	60
Heidelberg Borough	105
Churchill Borough	31
Glen Osborne Borough	46
Cheswick Borough	114
Blawnox Borough	38
Moon Township	93
Edgeworth Borough	104
White Oak Borough	66
Castle Shannon Borough	79
South Park Township	116
Whitaker Borough	11
Versailles Borough	42
Ben Avon Borough	100
Wilkins Township	36
Coraopolis Borough	55
Dormont Borough	73
Rankin Borough	2
Brackenridge Borough	29
East Deer Township	82
Leetsdale Borough	124
Mount Oliver Borough	4
Hampton Township	91
Springdale Borough	125
Wilmerding Borough	21
Millvale Borough	106
Collier Township	89
East Pittsburgh Borough	8
Braddock Hills Borough	19
Edgewood Borough	27
Sewickley Borough	90
Carnegie Borough	47
Glassport Borough	52
Pleasant Hills Borough	69
Emsworth Borough	111
Ingram Borough	30
Forest Hills Borough	37

Etna Borough	78
Tarentum Borough	40
Braddock Borough	1
Crafton Borough	80
Oakmont Borough	87
Harmar Township	97
Sharpsburg Borough	50
Avalon Borough	59
North Fayette Township	122
Bridgeville Borough	75
Green Tree Borough	64
Homestead Borough	3
Turtle Creek Borough	16
Jefferson Hills Borough	54
Brentwood Borough	25
Harrison Township	57
West View Borough	119
Stowe Township	20
McKees Rocks Borough	14
O Hara Township	44
Bellevue Borough	53
Bethel Park Municipality	70
Clairton	22
North Braddock Borough	5
Reserve Township	33
Munhall Borough	24
Shaler Township	96
Plum Borough	113
Robinson Township	109
North Versailles Township	17
Swissvale Borough	13
Kennedy Township	39
Duquesne	6
Baldwin Borough	35
Whitehall Borough	43
Mount Lebanon	85
McCandless Township	71
Monroeville Municipality	34
McKeesport	10
Scott Township	62
Wilkinsburg Borough	9
Ross Township	107
West Mifflin Borough	23
Penn Hills Municipality	12
Pittsburgh	18

Appendix D

Equity rank of neighborhoods and municipalities that do not have frequent transit service (lowest to highest)

Places with no frequent transit	Area	Rank
Arlington Heights	Neighborhood	9
St. Clair	Neighborhood	12
Mt. Oliver	Neighborhood	25
Spring Hill-City View	Neighborhood	26
Chartiers City	Neighborhood	33
East Pittsburgh Borough	Municipality	40
Pitcairn Borough	Municipality	52
Turtle Creek Borough	Municipality	54
North Versailles Township	Municipality	55
Stowe Township	Municipality	58
Hays	Neighborhood	60
Wilmerding Borough	Municipality	61
Clairton	Municipality	62
Wall Borough	Municipality	70
Port Vue Borough	Municipality	73
Brackenridge Borough	Municipality	74
Westwood	Neighborhood	76
Churchill Borough	Municipality	77
East McKeesport Borough	Municipality	78
Wilkins Township	Municipality	83
Forest Hills Borough	Municipality	84
Lincoln Place	Neighborhood	90
New Homestead	Neighborhood	91
Kennedy Township	Municipality	92
Tarentum Borough	Municipality	93
Chalfant Borough	Municipality	94
Versailles Borough	Municipality	98
Verona Borough	Municipality	103
Glen Osborne Borough	Municipality	104
Neville Township	Municipality	106
Ben Avon Heights Borough	Municipality	107
South Versailles Township	Municipality	109
Glassport Borough	Municipality	110
Jefferson Hills Borough	Municipality	112
Coraopolis Borough	Municipality	116
McDonald Borough	Municipality	117
Harrison Township	Municipality	118
Dravosburg Borough	Municipality	119
Avalon Borough	Municipality	121
Liberty Borough	Municipality	123

West Elizabeth Borough	Municipality	125
Green Tree Borough	Municipality	126
Lincoln Borough	Municipality	128
White Oak Borough	Municipality	129
South Fayette Township	Municipality	131
Leet Township	Municipality	132
Ridgemont	Neighborhood	133
Elizabeth Borough	Municipality	138
Fox Chapel Borough	Municipality	140
Aleppo Township	Municipality	143
Elizabeth Township	Municipality	148
East Deer Township	Municipality	149
Sewickley Heights Borough	Municipality	150
Oakdale Borough	Municipality	151
Sewickley Hills Borough	Municipality	153
Oakmont Borough	Municipality	154
Glenfield Borough	Municipality	155
Sewickley Borough	Municipality	160
Hampton Township	Municipality	163
Moon Township	Municipality	166
Indiana Township	Municipality	168
Kilbuck Township	Municipality	169
Harmar Township	Municipality	171
Franklin Park Borough	Municipality	172
West Deer Township	Municipality	173
Ben Avon Borough	Municipality	174
Haysville Borough	Municipality	175
Crescent Township	Municipality	176
Frazer Township	Municipality	178
Edgeworth Borough	Municipality	179
Millvale Borough	Municipality	181
Springdale Township	Municipality	188
Emsworth Borough	Municipality	189
Ohio Township	Municipality	190
Plum Borough	Municipality	191
Cheswick Borough	Municipality	192
Richland Township	Municipality	193
South Park Township	Municipality	194
Bradford Woods Borough	Municipality	195
Pine Township	Municipality	197
Fawn Township	Municipality	200
North Fayette Township	Municipality	202
Bell Acres Borough	Municipality	204
Leetsdale Borough	Municipality	205
Springdale Borough	Municipality	206
Findlay Township	Municipality	207

Marshall Township	Municipality	212
Forward Township	Municipality	213
Trafford Borough	Municipality	214
Pennsbury Village Borough	Municipality	215

Appendix E

Rank of routes in the Port Authority of Allegheny County network according to their equity score

Route	Average Equity Score	Rank
79	0.380305	1
89	0.332452353	2
60	0.320732308	3
82	0.313825528	4
74	0.312225	5
86	0.302484289	6
P7	0.299198694	7
P17	0.297843719	8
P3	0.287387531	9
59	0.284340196	10
77	0.283280841	11
71D	0.275870881	12
83	0.269950733	13
P2	0.269372174	14
57	0.267462143	15
71	0.267461833	16
61C	0.266756596	17
P78	0.266485396	18
68	0.265712577	19
P67	0.265108737	20
P68	0.264238596	21
P1	0.261261429	22
51L	0.258665395	23
P69	0.25848798	24
P71	0.2572465	25
26	0.252149905	26
P12	0.25123137	27
71C	0.248792795	28
55	0.247784333	29
61A	0.246289857	30
44	0.245865371	31
P76	0.245329439	32
54	0.244667644	33
15	0.242329958	34
71A	0.242105472	35
11	0.240992789	36
P16	0.240841787	37
61B	0.239624558	38
81	0.236882417	39
61D	0.236633971	40

27	0.235680957	41
93	0.234899814	42
75	0.234412689	43
56	0.233910235	44
52L	0.232680103	45
69	0.232061077	46
88	0.23070837	47
6	0.227373765	48
16	0.224965469	49
67	0.224720283	50
22	0.222124313	51
71B	0.222090973	52
53	0.2212938	53
48	0.218591536	54
8	0.218441792	55
P10	0.218333317	56
51	0.217786958	57
17	0.216431633	58
53L	0.215472783	59
O5	0.209163815	60
13	0.208525742	61
12	0.208491241	62
43	0.207696133	63
64	0.20617975	64
O12	0.205988848	65
87	0.205872735	66
21	0.205422032	67
58	0.205076226	68
20	0.204006722	69
O1	0.20250119	70
28X	0.199495947	71
G31	0.195779457	72
24	0.195621136	73
G2	0.193806458	74
Y46	0.193227818	75
14	0.1906352	76
31	0.189180333	77
1	0.187830846	78
19L	0.186194536	79
G3	0.182913182	80
29	0.182617935	81
41	0.182481929	82
Y49	0.180164742	83
7	0.179889308	84
4	0.17963	85

2	0.178544486	86
65	0.17850044	87
Y1	0.178212611	88
91	0.17809988	89
P13	0.178014935	90
Y47	0.176901273	91
36	0.176787486	92
39	0.176470423	93
18	0.174854143	94
38	0.173650029	95
RED	0.173532086	96
BLSV	0.173266333	97
Y45	0.172037633	98
BLLB	0.171472257	99
40	0.157034786	100
DQI	0.069898	101
MI	0.069898	102