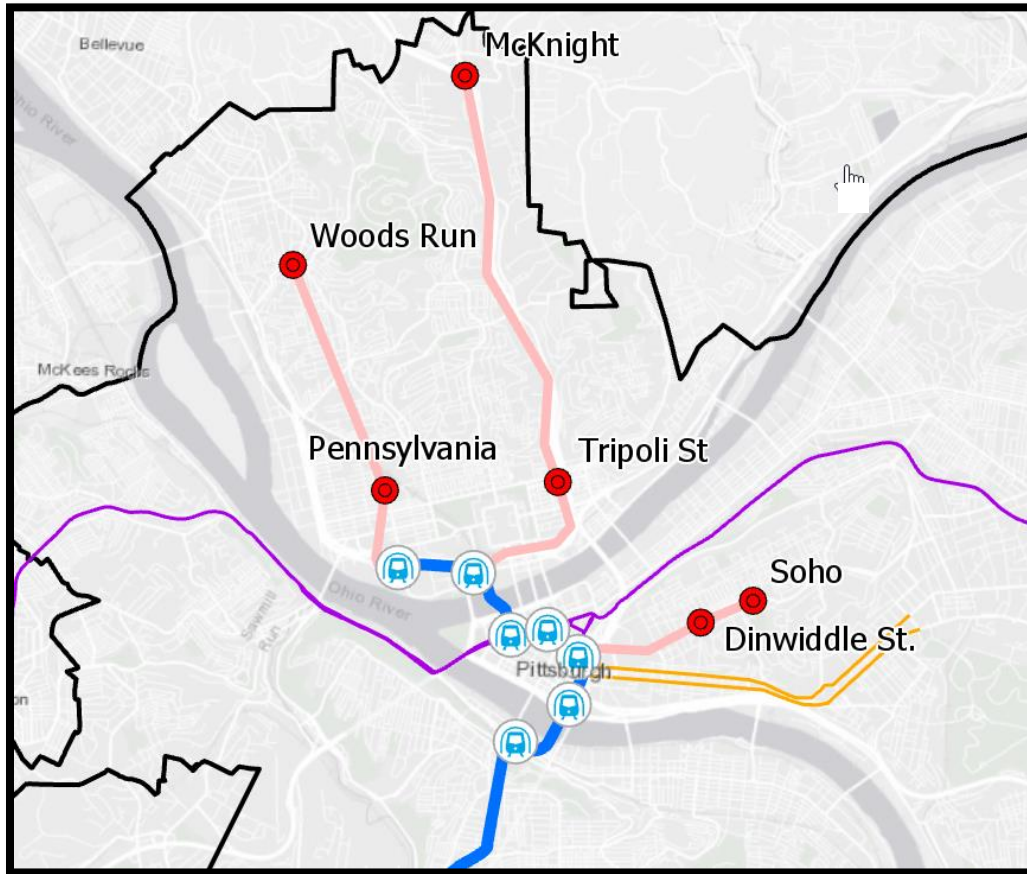


# GIS: Analyzing Potential Expanded Light Rail Coverage in Pittsburgh

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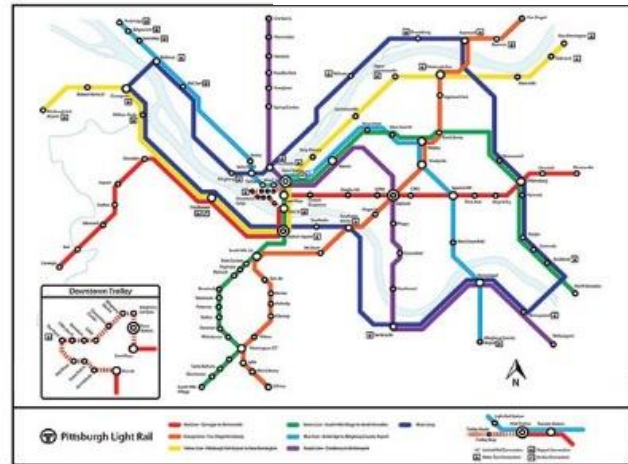
## Topic Statement

Many have argued that there is opportunity to expand Pittsburgh's existing light rail network – some have gone as far to draw maps that place ideal stations across the city. While these pictures are aesthetically-pleasing, there is no real logic or analytical rigor underlying these maps. This project uses GIS to consider where Pittsburgh could expand its light rail service and place new stops.

The proposed new light rail stops will be selected and evaluated by considering Transit-Oriented Development (TOD) concepts and values. The clients of this project include the city of Pittsburgh and the Port Authority of Allegheny County.

*Note: this approach is slightly modified from the initial proposal. It was determined it would be more realistic and productive to analyze distinct corridors of expansion instead of evaluating individual proposed new stations on a case-by-case basis.*

Exhibit 1: Fictional idealized light rail



## Light Rail in Pittsburgh: Brief

Exhibit 2



The modern light rail in Pittsburgh dates back nearly 100 years to an old streetcar network. Known locally as the “T”, Pittsburgh light rail coverage extends from the South Hills suburbs to Heinz Field in the North Shore (Exhibit 2). The most recent light rail extension was completed in 2012, connecting downtown to Pittsburgh's North Shore. The project was widely-criticized both locally and on the national stage for delays, management issues, and runaway costs.

## Approach / Methodology: Transit Oriented Development Review

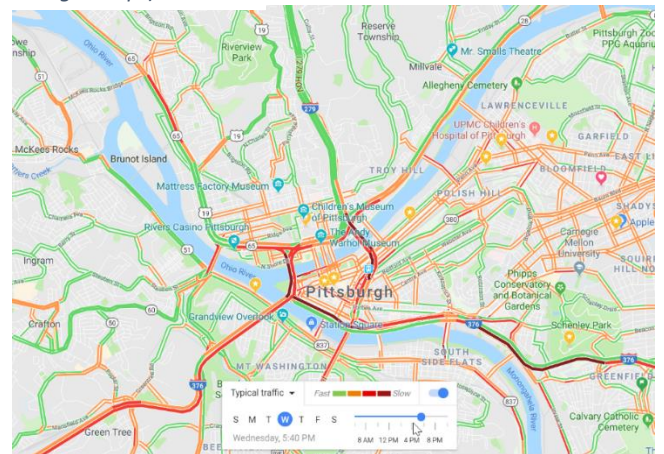
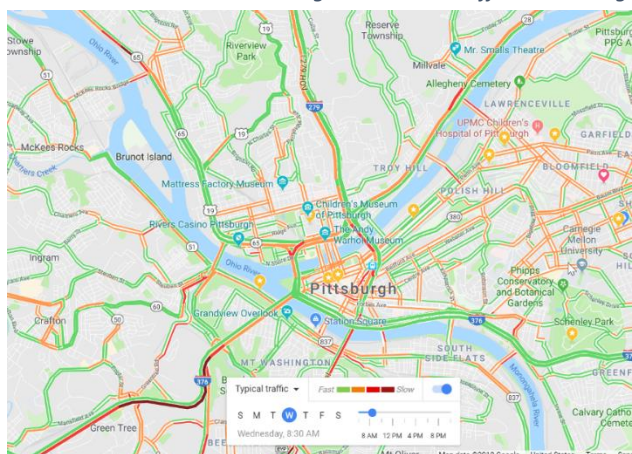
Transit-oriented development, or TOD, is “a type of community development that includes a mixture of housing, office, retail and/or other amenities integrated into a walkable neighborhood and located within a half-mile of quality public transportation.”<sup>i</sup> According to the National League of Cities, TOD is an approach to development that focuses land uses around a transit station or within a transit corridor. Typically, it is characterized by mixed use areas, moderate to high density orientation/connectivity, transportation options, and reduced parking.<sup>ii</sup>

Responsible TOD aims to achieve sustainable urban growth. Stressing the importance of responsible TOD design, the Federal Reserve Bank of San Francisco notes TOD is positioned to benefit low-income communities, but most TOD projects do not focus on the interests of the poor and have sometimes disrupted low-income neighborhoods.<sup>iii</sup> This project believes in the responsible design of TOD, providing greater access to low-income communities to public transportation and economic opportunity.

**Project Approach.** This project will evaluate the selected new light rail stops on the following TOD-inspired criteria:

- Criterion 1: High population density within a half-mile radius of any new proposed metro stop.
- Criterion 2: A new stop should be located in an accessible, mixed-use area where there will presumably be options for housing, various commercial outlets/offices/developments, parks or community spaces, and the opportunity for further development.
- Criterion 3: Assuming responsible TOD striving for equitable outcomes, a new light rail stop will be considered more desirable if it provides increased access to low-income communities.
- Criterion 4: TOD aims to reduce the use of private cars. Like any large city, Pittsburgh deals with significant challenges of traffic (see Exhibit 3 & 4). A light rail stop, therefore, will be considered more desirable if it is located in an area that is less connected with current public transportation options and would decrease the number of individuals commuting via private vehicles.

*Exhibits 3 & 4 – Midweek Average Rush Hour Traffic in Pittsburgh (via Google Maps)*

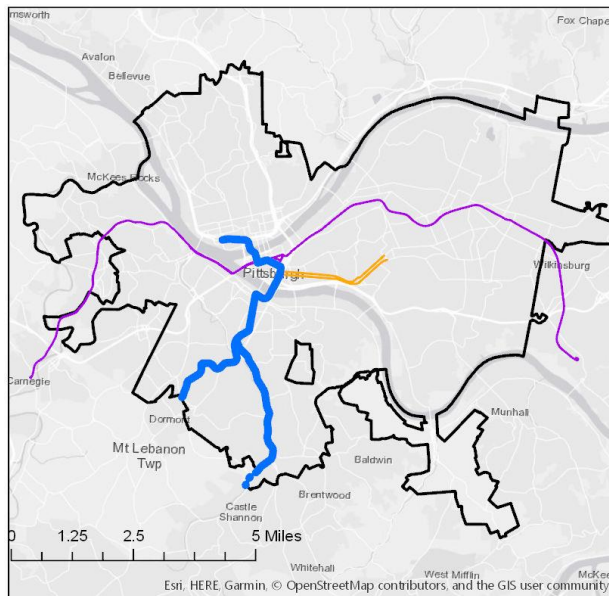




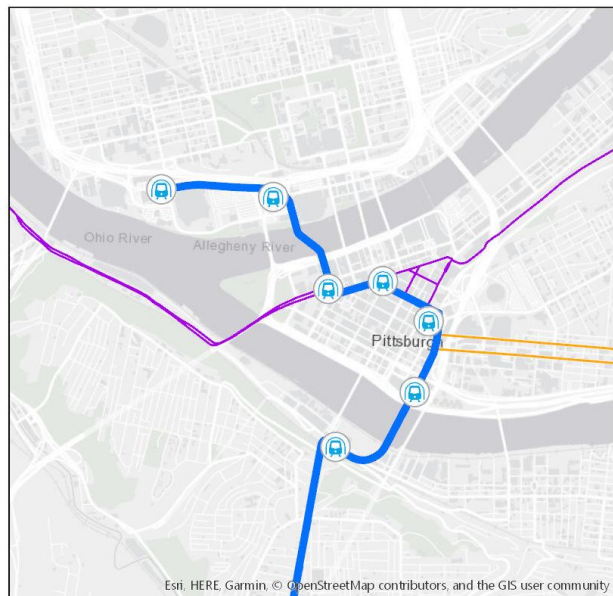
## Scope Limitation and Corridors for Light Rail Extension

The area of focus is downtown Pittsburgh; light rail stations will only be considered in the areas adjacent to the existing light rail network.






It is important to note the alternative rapid transit systems in Pittsburgh that are comparable to light rail in Pittsburgh. The West Busway and the Martin Luther King Jr. East Busway are traffic-free road mass transit options that connect downtown Pittsburgh with select neighborhoods and suburbs. Moreover, the city continues to pursue federal funding for a Bus Rapid Transit system (BRT) that connects downtown with the highly-populated areas around the Oakland neighborhood. The estimated cost for the BRT system is 195.5 million.<sup>iv</sup> These existing transport systems and the proposed BRT must be considered when weighing potential light rail expansion, as it is not sensible to plan in or evaluate areas where comparable transit options are available or being pursued.



Pittsburgh: Full Extent



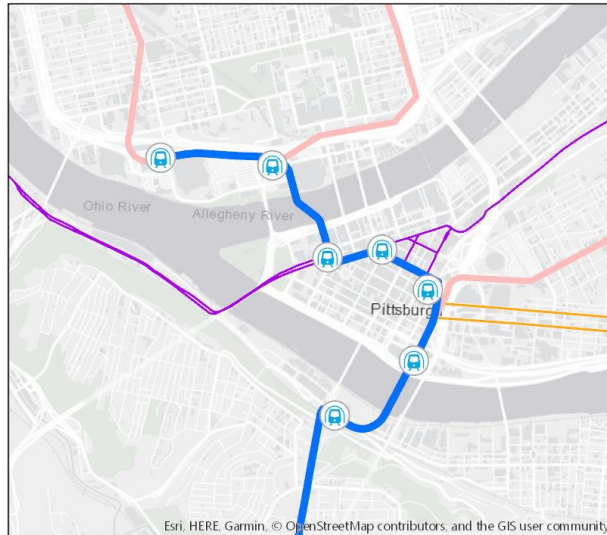
Downtown: Light Rail Lines

-  Downtown Light Rail Stops
-  Existing Light Rail Lines
-  Express Busways
-  Proposed Bus Rapid Transit BRT
-  Pittsburgh Border

 Map by Jeff Pflanz

## GIS Analysis 1: Locating the Proposed Light Rail Stops

The areas considered for light rail extension are in three distinct corridors. As one may read below, each corridor was identified after researching and identifying existing public discussions and ideas around expanding the light rail. There are two stations identified for each potential line. Each extension of the light rail originates from a specified existing light rail station. The three corridors of extension fall outside the existing coverage of comparable rapid public transit options.



### Downtown: Light Rail Lines & Proposed Extensions

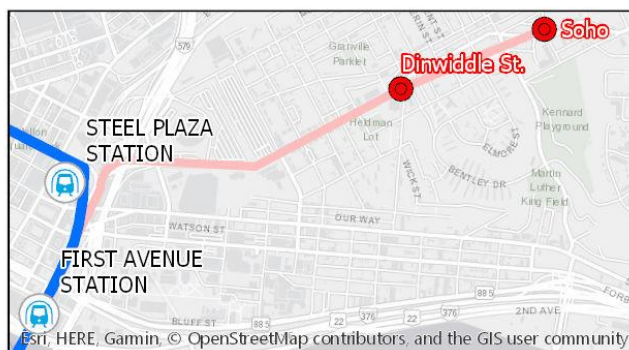
- Downtown Light Rail Stops
- Existing Light Rail Lines
- New Light Rail Service Lines/Area
- Express Busways
- Proposed Bus Rapid Transit BRT
- Pittsburgh Border

Map by Jeff Pflanz

### 1) Spine Line: Centre Ave / Hill District Corridor (Spine Line)

This corridor would junction at the existing First Avenue light rail stop and run in the districts largely not covered between the East Busway and the proposed BRT Oakland plan. These stops were inferred to be viable given that the *Spine Line Corridor Study*<sup>v</sup> by the Port Authority of Allegheny County. Stops included are Dinwiddle and Soho (as specified by the *Spine Line Corridor Study*).

*TOD perspective on land use (Criterion 2):* The stops were provided. Analysis of the zoning/ land use around the stops indicates that these stops would be located in commercial areas surrounded by moderate-density residential units and planned developments.



- Proposed Light Rail Stops
- Downtown Light Rail Stops
- Existing Light Rail Lines
- New Light Rail Service Lines/Area

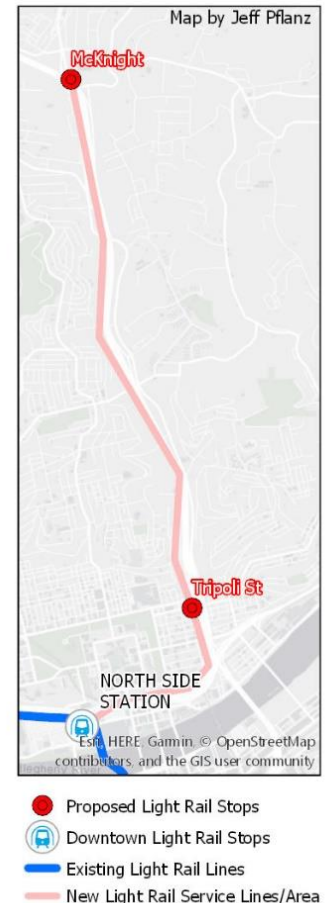
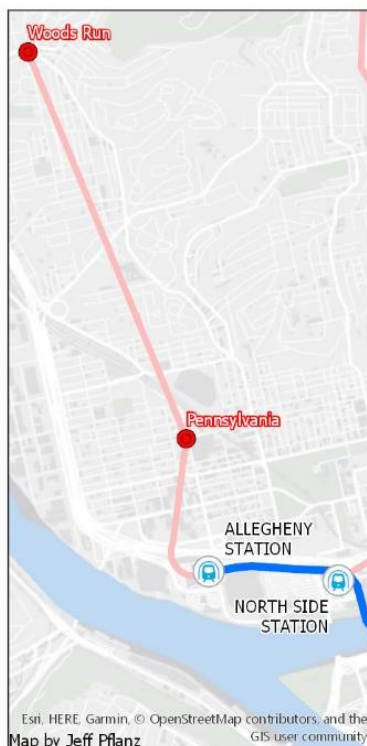
Map by Jeff Pflanz

## 2) Towards Cranberry (Cranberry Line)

Shortly after the completion of the North Shore Connector, The Pittsburgh Post-Gazette reported on discussions between engineer Kevin Creagh, data analyst Steve DiMiceli, and Allegheny County Executive Rich Fitzgerald. Their discussions revolved around extending light rail coverage to Cranberry utilizing the “the vastly underused High Occupancy Vehicle (HOV) lanes of I-279's northern branch.”<sup>vi</sup> The cost of an 18-mile project was estimated to be \$1.385 billion.<sup>vii</sup> To keep analysis manageable, only the first two stops of their proposal are considered.

A graphic included in the Post-Gazette article indicated the first two stops on this Cranberry branch: *Tripoli St.* and *McKnight*.<sup>viii</sup> The new service line originates from the North Side Station.

*TOD perspective on land use (Criterion 2):* Stops were provided, but both are in mixed-use areas with existing commercial development and parks.



## 3) Towards Pittsburgh Airport (Airport Line)

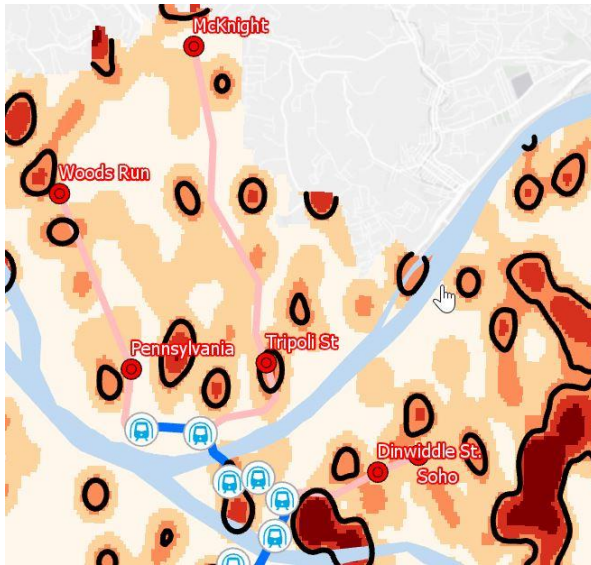
Past discussions have also centered around extending light rail in the direction of the Pittsburgh Airport –again involving Allegheny County Executive Rich Fitzgerald. This year at the “State of the Airport” event, Allegheny County Airport Authority CEO Christina Cassotis indicated her continued support for the idea alongside Fitzgerald.<sup>ix</sup> The cost of such a project, however, would again reach billions of dollars.

There is no formal proposal accessible, so there was some liberty in selecting the new stops in this corridor. After considering TOD principles, active commercial areas (as shown on Google Maps), and Pittsburgh zoning data, two stops were selected: *Pennsylvania* and *Woods Run*. Both would seemingly be feasible on a line towards the airport. This line would originate from the existing Allegheny Station.

*TOD perspective on land use (Criterion 2):* Both stops were not provided. After analysis of the area, these stops were placed on the edges of different land use zones (mixed use) where there appears to be potential for development.



## Overall KDS Analysis of Specified Stops

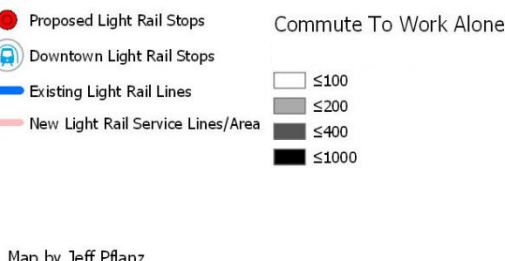
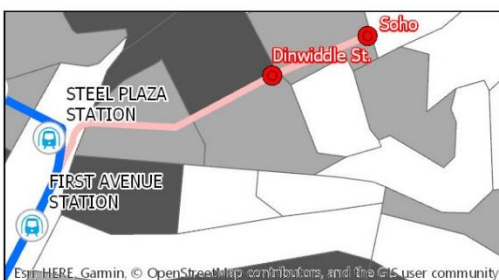
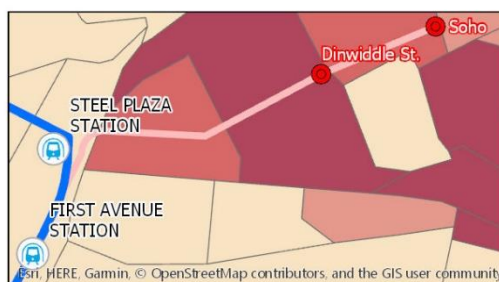


Population is a significant factor when considering the development of new public transportation. When it comes to light rail, it was necessary to verify that selected stops mentioned above were near areas with high population density. Kernel Density Smoothing (KDS) was utilized to smooth Census Block population data; the resulting raster data was used for analysis. As the figure shows, all of the proposed new light rail stops are within a reasonable distance of a threshold that includes areas of the highest population density.

## GIS Analysis 2: Analyzing Proposed Light Rail Coverage

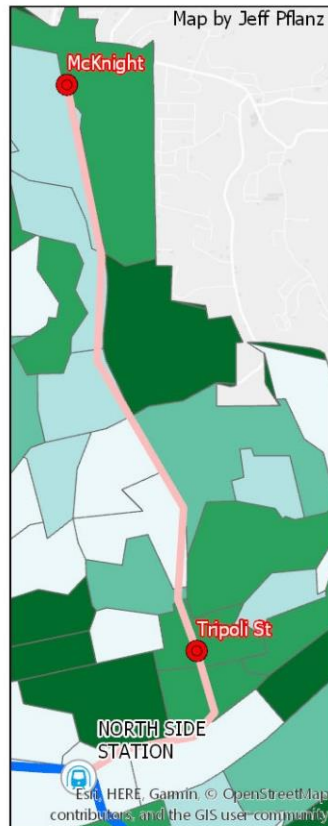
As described above, each of the three lines new (with two stops selected for each) will be analyzed using the four TOD criteria. The maps below provide pertinent visualizations on the proposed light rail lines.

### 1) Spine Line Stops: Relevant Census Block Data Visualization





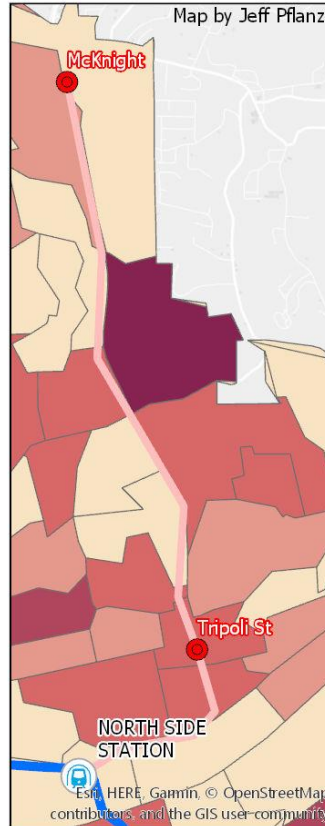
## 2) Cranberry Line Stops: Relevant Census Block Data Visualization



- Proposed Light Rail Stops
- Downtown Light Rail Stops
- Existing Light Rail Lines
- New Light Rail Service Lines/Area

### Population

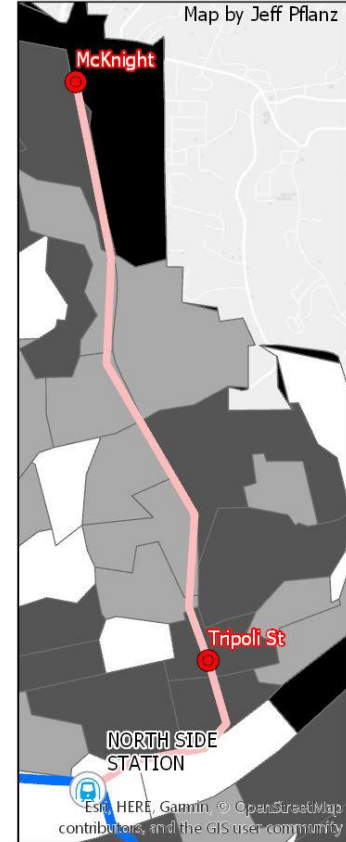
- ≤500
- ≤700
- ≤900
- ≤1200
- ≤5000



- Proposed Light Rail Stops
- Downtown Light Rail Stops
- Existing Light Rail Lines
- New Light Rail Service Lines/Area

### Population Under Poverty Line

- ≤100
- ≤200
- ≤400
- ≤800
- ≤1500

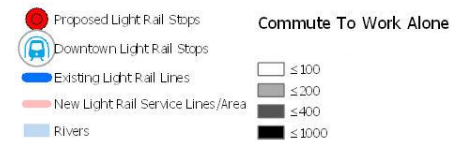
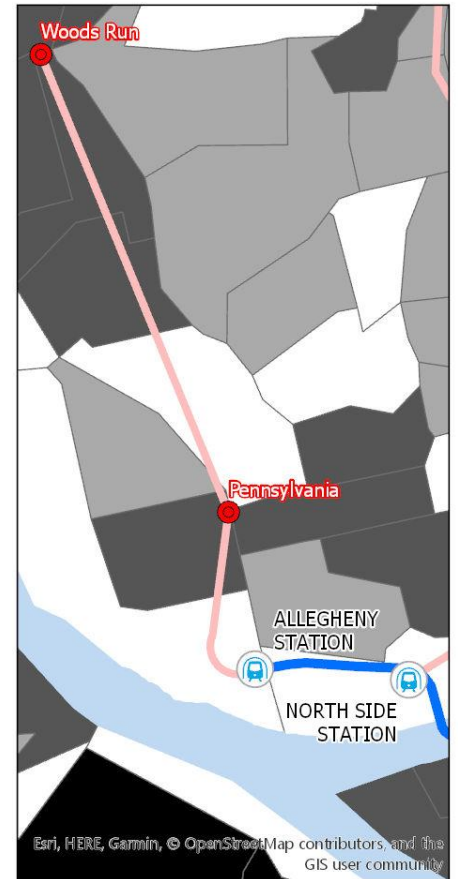
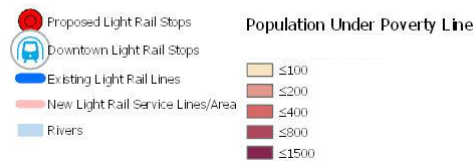
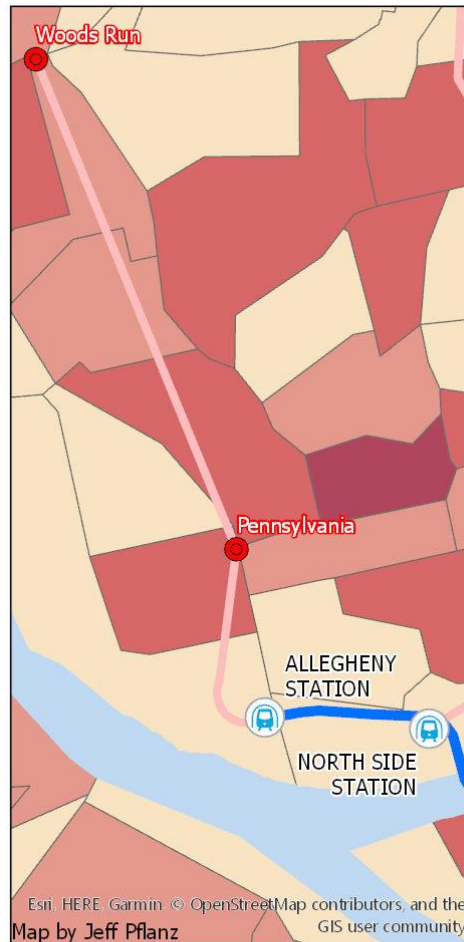
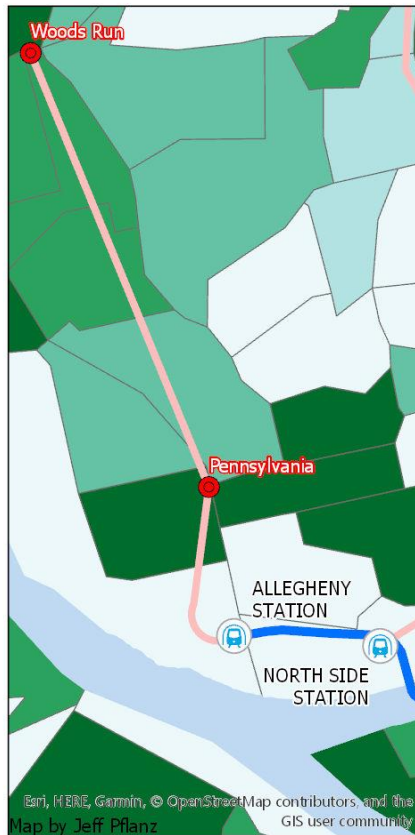


- Proposed Light Rail Stops
- Downtown Light Rail Stops
- Existing Light Rail Lines
- New Light Rail Service Lines/Area

### Commute To Work Alone

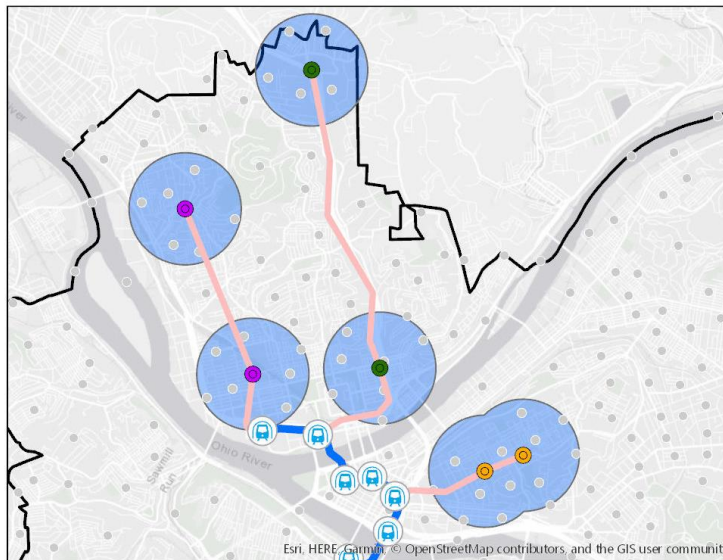
- ≤100
- ≤200
- ≤400
- ≤1000

### 3) Airport Line Stops: Relevant Census Block Data Visualization



## Findings

The data/maps above include information on population, individuals below poverty line, and commuters around each of the proposed new light rail stops. TOD is anchored in developing transportation hubs within a reasonable walking distance (typically half a mile, or roughly a ten minute walk). Therefore, a half-mile buffer was designed around each proposed light rail site. Using spatial analysis, the following summary statistics were computed for each of the three proposed light rail line on the relevant TOD criteria:



Buffer Analysis of Population Around Proposed Stops

- Spine Line Stops
- Airport Line Stops
- Cranberry Stops
- Downtown Light Rail Stops
- Existing Light Rail Lines
- New Light Rail Service Lines/Area
- 2016 ACS Block Centroids
- Half Mile Buffer Areas
- Pittsburgh Border

### Summary Statistics After Spatial Join

Individuals within half-mile buffer for each proposed light rail line (including both stations)

	Total Population	Population Under Poverty Line	Population Use Vehicle for Commute	Population Use Vehicle: Commuting Alone	Total Housing Units in Area
<b>Spine Line</b>	9325	3708	1464	1181	5170
<b>Cranberry Line</b>	11236	2383	3387	2965	6724
<b>Airport Line</b>	10178	1879	3955	3501	6359

## Analyzing each line:

*Spine Line.* The population within walking distance of the Dinwiddle and Soho stations is the lowest among the proposed stations, though there are more individuals below the poverty line. In terms of reducing vehicles on the road, however, there simply are not many individuals that seem to own/use vehicles to commute. This area is relatively urban compared to the other proposed lines and presumably has greater access to other transport options (like public buses).

*Cranberry Line.* Relative to the other proposed lines, the Cranberry option - with stations at Tripoli St. and McKnight – covers the largest population within walking distance. Moreover, there are a significant number of individuals commuting to work alone. This may reflect poor access to efficient public transportation in the status-quo.

*Airport Line.* Like the Cranberry option, the Airport line (with the Pennsylvania and Woods Run stops) covers a significant population and individuals commuting to work alone. The areas surrounding these proposed stops, however, have fewer individuals experiencing poverty.

## Conclusions and Future Work

While the analysis above provides compelling evidence for where the light rail could go next, factors external to this analysis will likely impede any extension of light rail in the near future. First and foremost, developing light rail has been very costly in Pittsburgh. The most recent North Shore extension took decades to plan, exceeded its budget by tens of millions, and was widely criticized.

It is also clear that the Bus-Rapid Transit (BRT) system to Oakland is the current top mass transit priority of county officials.<sup>x</sup> And for good reason – the ambitious project has a projected cost of only \$195 million. In comparison, all of the proposed light rail line extensions above would be far more expensive to implement – with some cost projections reaching billions of dollars.

That said, the choice between BRT and light rail does not have to be an either/or choice. Both together can benefit the public. Kevin Creagh, engineer and advocate of the Cranberry light rail extension, notes: “BRT is a good idea for connecting urban, developed centers together — like Oakland and Pittsburgh. But LRT is a far superior capacity-providing solution to link areas that are further apart — such as bridging the gap of the 18 miles between Cranberry and Pittsburgh.”<sup>xi</sup>

**Recommendation for Light Rail.** Absent the political and financial considerations, this analysis indicates that there is potential to extend light rail service to the north. The Spine Line option, as considered decades ago, no longer seems as viable considering the TOD criteria, existing public transportation options, the enormous cost of construction, and plans to develop BRT.

Under the TOD framework, both the Cranberry and Airport lines are relatively similar in terms of coverage and impact. The Cranberry line, however, has seemingly garnered more public consideration and planning. As Kevin Creagh and Steve Dimiceli have argued, it makes sense to continue light rail above the ground along stretches of the I-279 corridor to the north. This would also be a seemingly more cost effective option, as it could use existing infrastructure and not require as much tunneling.



## Data Sources

- Mass transit stops/data, zoning, land use, tract/block outlines: Western Pennsylvania Regional Data Center <http://www.wprdc.org/>
- Downloaded 2016 American Community Survey data for Allegheny County on fields of interest. Downloaded from US Census American FactFinder website.  
<https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>

## Process Log

- 1) Data Collection and Download
  - a. Download Transit data (Pittsburgh transit stops and lines) from Western Pennsylvania Regional Data center
  - b. Download Allegheny tracts, Download Pittsburgh land-use data (zones)
  - c. Download select data from US Census American FactFinder: 2016 ACS block data on Allegheny County on: Population, Poverty, Method of Transport, Poverty
  - d. Collect Pittsburgh outline / neighborhood polygons
- 2) Data cleaning / layer creation
  - a. Open GIS transit data in ArcGIS, use select by attribute query to identify light rail and rapid transit polylines, delete unneeded bus route data. Clip to study area (city of Pittsburgh)
  - b. Open ACS block .csv files. Compile useful data into one file, exclude unnecessary data. Import table into ArcGIS
  - c. Table join ACS combined data to Pittsburgh blocks (study area, only city boundary blocks). Create new layer with relevant ACS data (added many times to symbolize different features).
  - d. Digitizing
    - i. Make new layer, points, with potential light rail stop locations
    - ii. Digitize proposed Oakland BRT layer
- 3) Analysis: Locations for new metro stops
  - a. KDS Population. Create block centroids containing population, use point layer for KDS and create raster. Make general threshold (contour list) to identify areas of highest population.
  - b. After analysis (explained in paper), digitize new metro stop locations and digitize polyline for possible metro line extension (from existing stops).
- 4) Evaluation of locations / metro lines
  - a. Isolate each line with two metro stops (create three new layers) and title
  - b. Create centroids for all block data. (Add geometry attributes > feature to point tool)
  - c. Create (dissolved) buffers for each of the three metro extension lines (two stops each)
  - d. Spatial join block data centroids to the three metro lines. Used to compute TOD coverage.
- 5) Symbolology review. Make maps more aesthetically-pleasing and readable
- 6) Design and export layouts as necessary

## References

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- <sup>i</sup> <http://www.reconnectingamerica.org/what-we-do/what-is-tod/>
- <sup>ii</sup> [https://web.archive.org/web/20161220173407/http://www.sustainablecitiesinstitute.org/topics/land-use-and-planning/transit-oriented-development-\(tod\)](https://web.archive.org/web/20161220173407/http://www.sustainablecitiesinstitute.org/topics/land-use-and-planning/transit-oriented-development-(tod))
- <sup>iii</sup> Federal Reserve Bank of San Francisco. [https://www.frbsf.org/community-development/files/M\\_Soursourian.pdf](https://www.frbsf.org/community-development/files/M_Soursourian.pdf)
- <sup>iv</sup> <https://www.portauthority.org/paac/CompanyInfoProjects/brt.aspx>
- <sup>v</sup> “Spine Line Corridor Study” <http://www.briem.com/files/spineline1993.pdf>
- <sup>vi</sup> Kevin M. Creagh and Steve Dimiceli. “Go North, Light Rail” <https://www.post-gazette.com/local/north/2012/12/23/The-Next-Page-Go-north-light-rail/stories/201212230177>
- <sup>vii</sup> <https://triblive.com/news/alleggheny/3601107-74/north-million-rail>
- <sup>viii</sup> [http://old.post-gazette.com/pg/images/201212/20121223next\\_light\\_rail900.png](http://old.post-gazette.com/pg/images/201212/20121223next_light_rail900.png)
- <sup>ix</sup> <https://triblive.com/local/alleggheny/13495089-74/pittsburgh-international-ceo-says-well-be-ready-if-light-rail-to-airport>
- <sup>x</sup> <https://triblive.com/local/alleggheny/13495089-74/pittsburgh-international-ceo-says-well-be-ready-if-light-rail-to-airport>
- <sup>xi</sup> Kevin M. Creagh and Steve Dimiceli. <http://www.thepointofpittsburgh.com/the-light-rail-north-concept/>