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Term Project

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Accessibility of Medical Facilities via Public Transportation in

Fairfax County, VA

Abstract:

In this examination of the Fairfax County, VA bus route network we were able to determine if there was suitable access to the medical facilities in the county via bus. This was accomplished by using python scripts calling Arc GIS tools. Using a combination of clip, buffer, and spatial join tools the conclusion was reached that the medical facilities in Fairfax VA were generally accessible to its population via the commuter bus system. It was found that of the 48 medical facilities in 43 were at least somewhat accessible by bus, 41 were accessible, and 39 were very accessible by bus. Meaning that only 5 medical facilities in Fairfax were determined to not be accessible by bus. With only 5 of 48 being determined to be not accessible it can be said that Fairfax medical infrastructure is suitably accessible to its populous but could still improve this with the expansion of its bus network.

Introduction:

Fairfax County is a large county in Northern Virginia just outside of Washington DC. Fairfax County is considered a part of the greater metropolitan area of Washington DC known as the DMV (District, Maryland, and Virginia), and like all major metropolitan areas is densely populated and suffers from consistent heavy traffic on their interstate and highway system and lack of parking. This heavy traffic and lack of access to free and reasonably priced parking has led to many people in the DMV to opt out of owning a vehicle and utilize public transportation options as their primary means of transportation, especially those in lower income homes.

This reliance on public transportation can come with some potential drawbacks on accessibility though. Not all necessary and vital amenities are always accessible via public transportation. For this reason, it is important for counties who have a significant portion of their populations that rely on public transportation, such as Fairfax, that their public transportation routes provide access to medical facilities. Having sufficient access to medically facilities can mean life or death for individuals in need of urgent, semi-urgent, or regular medical care. For this reason, the purpose of this project is to see if Fairfax County medical facilities are reasonably accessible by its public transportation network. The results that are derived from this project will help determine if there are areas in Fairfax that have medical facilities but limited metro access. This info will allow for recommendations for the expansion of Fairfax's bus system.

Materials and Methods:

For this project we utilized both Jupyter Notebook and ESRI ArcGIS Pro as the basis for the analysis of the datasets. For the data used in this project three data sets were pulled from Fairfax County, VA government website (which houses a sizeable geospatial data page for a county government website). The first dataset pulled contained all the medical facilities associated with Fairfax, including several that were not within the county borders but within driving distance. In total there were 76 medical facilities in the data set. The second data set pulled contained the bus routes for Fairfax's commuter bus network, many of which also extended outside of the county's borders. The last data set was a shape file containing the various governmental boundaries of the county. For this project the only boundary used was the county borders, so that we could accurately determine the medical facilities and bus routes in Fairfax County limits.

After pulling the datasets we then narrowed the data down to the pertinent data for this project by running clip script in Jupyter to remove the data points that fell outside of Fairfax County, clipping both the bus shape file and medical facility shape file with the county boundary file. This revealed that of the 76 medical facilities in the original dataset, that only 48 of them actually were in Fairfax County, and removed the excuse bus routes from our data (figure 1).

After we curatted the data down to the taget data point the next was to determine what would be consided accessiable for those seeking access to a medical facility using public transportation. Fot this we did not take into account medical emergencies because public transportation is generally not quick enough of a form of transportation for emargncy situations. So in determining accesiablity the client mind could be anyone experiancing mid to mild medical

distess up to those going in for routine check up experianing no physical distress of discomfort. With this in mind four classifications of accessiblity were created: Somewhat Accesiable, Accessiable, Very Accessiable, and Not Accesiable. Somewhat Accesiable are mediacl facilites that are within a mile distance from a bus route, this was chosen as the last classification that is accesiable because it is unreasonable for a person experiancing mild to mid level medical discomfort to need to walk more than a mile to a medical facility. Accessiable are medical faclited within a half mile of a bus route. Very accessible are medical facilited that are with in a quarter mile of a bus route. Medical facilites that are outside of a mile from a bus route are deemed Not Accessable.

To determin which of our medical facilites fell into which classification we needed to create buffers in jupyter using the arcpy.Buffer_anylsis function, one for each of our first three classifications. We created a 1mile, .5 mile and .25 buffer respectivley for each of our classifications. Once we had the buffer created we then needed to run an intersect to captur the bus routes that intersected the buffer zones createcd in the previous step using. We did so by using the model builder in ArcGIS Pro to convert the intersect tool into a callable python function, arcpy.analysis.Intersect(). Then an intersect was ran for each of the three buffers, resulting in the following map (Figure2).

`After running our intersects we can see that there are a few buffer zones that are missing bus routes at all three levels of buffer. To figure out which medical facilites are missing bus routes we ran a series of spatial joins between the intersects and the buffers using the arcpy.analysis.SpatialJoin() function. This essential creates a new attribute table combinging the information from the intersect and buffers. But to utilize data that is in an attribute table with

python script we first need to create a cursor for each attribute table that we created with our

spatial joins so we can get out results using for loops on the cursors.

Results:

After running the clips we were able to get a pretty clear picture of what the distribution

of medicalfacilites in Fairfax County looked like as well as their bus route network. As shown in

Figure 1 medical faciles are pretty well dispersed across Fairfax, with few being present near

the southwestern border. The bus routes however are a little less disppesrsed, similaryly

missing much of the southeastern portion of the state, but also missing the northern most potion

of the county and an out crop on the county's eastern border with Arligton City.
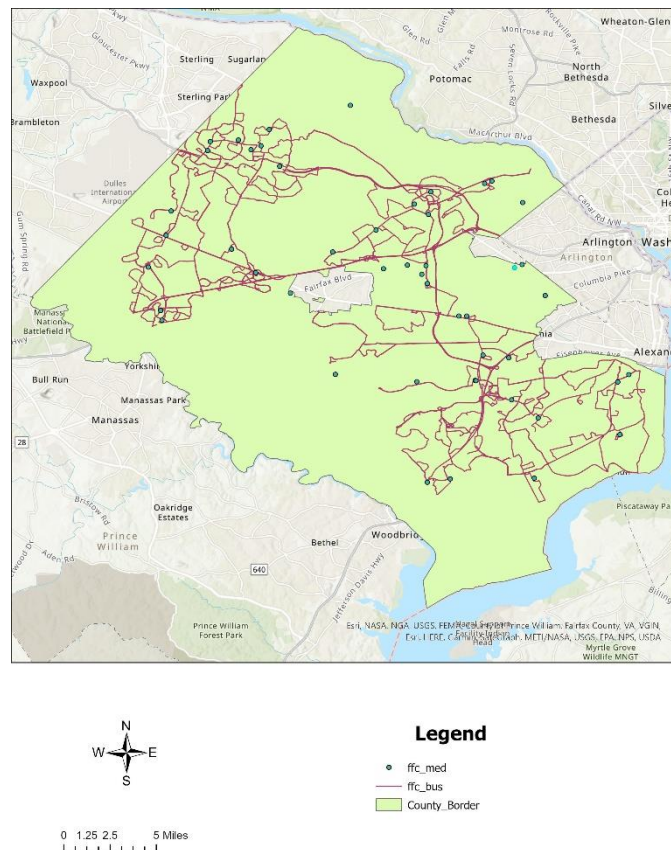
Figure 1

Once we add the buffers and intersects to the map (Figure2) we get a better understanding of the distance from the medical facilities that the bus routes are. In particular we can see that the medical facility in the north and the ones near Arlington are definitely more than a mile away from the nearest bus route. From the map we can also see more clearly which portions of the bus routes actually intersect with the buffer layers.

Figure 2
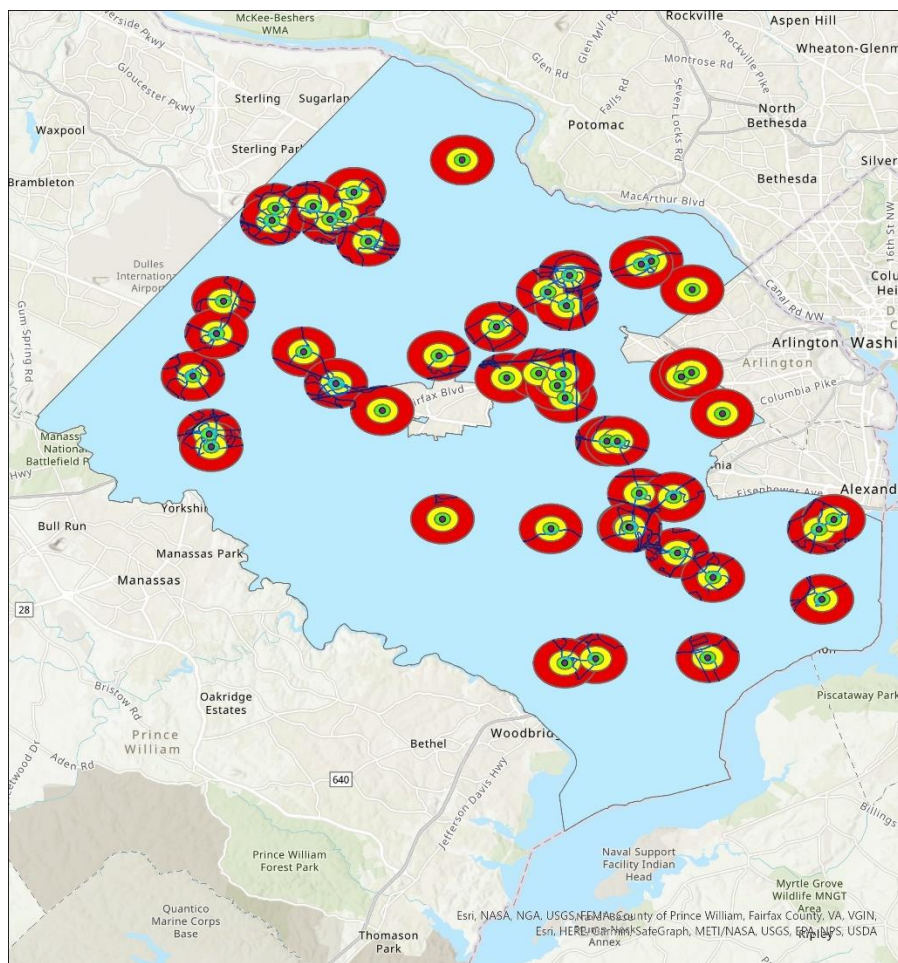
After we ran our spatial joins we had the attribute tables that would provide the information to answer the question about if Fairfax medical facilites are accessaible via bus. We were able to idedify this by running an arcpy.da.SerchCusor() with a for loop that denoted the accesiablity for each join as shown in Figure 3.

Figure 3

```python
mile_cursor = arcpy.da.SearchCursor (miles_join, ['DESCRIPTIO', 'ROUTE_NUMB', 'SHAPE_Leng'])
for row in mile_cursor:
    if row[2] != 0:
        print(row[0], 'is somewhat accessiable' )
    elif row[2] == 0:
        print(row[0], "is not accessiable")
```

```
RESTON HOSPITAL CENTER is somewhat accessiable
CENTREVILLE URGENT CARE is somewhat accessiable
DOMINION HOSPITAL is not accessiable
INOVA FAIRFAX HOSPITAL is somewhat accessiable
WALK IN MEDICAL CARE - BURKE is somewhat accessiable
FORT BELVOIR COMMUNITY HOSPITAL is somewhat accessiable
DOMINION URGENT CARE is somewhat accessiable
INOVA EMERGENCY ROOM - RESTON/HERNDON is somewhat accessiable
INOVA FAIR OAKS HOSPITAL is somewhat accessiable
INOVA MOUNT VERNON HOSPITAL is somewhat accessiable
INOVA URGENT CARE CENTER - CENTREVILLE is somewhat accessiable
WALK IN MEDICAL CARE - FAIR OAKS is somewhat accessiable
VUPC URGENT CARE is somewhat accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE - LORTON is somewhat accessiable
INOVA EMERGENCY ROOM - FRANCONIA/SPRINGFIELD is somewhat accessiable
INOVA HEALTHPLEX LORTON is somewhat accessiable
CAREMOW URGENT CARE - CENTREVILLE is somewhat accessiable
CAREMOW URGENT CARE - CHANTILLY is somewhat accessiable
PATIENT FIRST - CHANTILLY is somewhat accessiable
PATIENT FIRST - ALEXANDRIA is somewhat accessiable
INOVA URGENT CARE CENTER - RESTON is somewhat accessiable
INOVA URGENT CARE CENTER - TYSONS is somewhat accessiable
INOVA URGENT CARE CENTER - WEST SPRINGFIELD is somewhat accessiable
INOVA URGENT CARE CENTER - VIENNA is somewhat accessiable
AEHS ANNANDALE OFFICE is somewhat accessiable
AEHS FAIRFAX OFFICE is somewhat accessiable
CONCENTRA URGENT CARE - ALEXANDRIA is somewhat accessiable
CONCENTRA URGENT CARE - FAIRFAX is somewhat accessiable
MEDICAL ACCESS URGENT CARE - ALEXANDRIA is somewhat accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE - TYSONS is somewhat accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE-OLD TOWN is somewhat accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE-FALLS CHURCH is not accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE - FAIRFAX is somewhat accessiable
OAKTON URGENT CARE is somewhat accessiable
MCLEAN IMMEDIATE CARE FAMILY MEDICAL CENTER is somewhat accessiable
RESTON MEDICAL CENTER is somewhat accessiable
TYSONS CORNER MEDICAL CENTER is somewhat accessiable
OLD DOMINION URGENT CARE is not accessiable
NOVA PATIENT CARE - FALLS CHURCH is not accessiable
FAIRFAX URGENT CARE AND HEALTHPLEX is somewhat accessiable
MCLEAN MEDICAL CENTER is somewhat accessiable
ACE MEDICAL CARE is not accessiable
MILLENNIUM MEDICAL CARE - FAIRFAX is somewhat accessiable
MILLENNIUM MEDICAL CARE - HERNDON is somewhat accessiable
PROGRESSIVE URGENT & PRIMARY CARE is somewhat accessiable
FAMILY IMMEDIATE CARE is somewhat accessiable
PEDIATRICS URGENT CARE - SPRINGFIELD is somewhat accessiable
PEDIATRICS URGENT CARE - HERNDON is somewhat accessiable
```

```python
In [61]:  half_cursor = arcpy.da.SearchCursor (half_join, ['DESCRIPTIO', 'ROUTE_NUMB', 'SHAPE_Leng'])
for row in half_cursor:
    if row[2] != 0:
        print(row[0], 'is accessiable' )
    elif row[2] == 0:
        print(row[0], "is not accessiable")
```

```
RESTON HOSPITAL CENTER is accessiable
CENTREVILLE URGENT CARE is accessiable
DOMINION HOSPITAL is not accessiable
INOVA FAIRFAX HOSPITAL is accessiable
WALK IN MEDICAL CARE - BURKE is not accessiable
FORT BELVOIR COMMUNITY HOSPITAL is accessiable
DOMINION URGENT CARE is accessiable
INOVA EMERGENCY ROOM - RESTON/HERNDON is accessiable
INOVA FAIR OAKS HOSPITAL is accessiable
INOVA MOUNT VERNON HOSPITAL is accessiable
INOVA URGENT CARE CENTER - CENTREVILLE is accessiable
WALK IN MEDICAL CARE - FAIR OAKS is accessiable
VUPC URGENT CARE is accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE - LORTON is accessiable
INOVA EMERGENCY ROOM - FRANCONIA/SPRINGFIELD is accessiable
INOVA HEALTHPLEX LORTON is accessiable
CAREMOW URGENT CARE - CENTREVILLE is accessiable
CAREMOW URGENT CARE - CHANTILLY is accessiable
PATIENT FIRST - CHANTILLY is accessiable
PATIENT FIRST - ALEXANDRIA is accessiable
INOVA URGENT CARE CENTER - RESTON is accessiable
INOVA URGENT CARE CENTER - TYSONS is accessiable
INOVA URGENT CARE CENTER - WEST SPRINGFIELD is accessiable
INOVA URGENT CARE CENTER - VIENNA is accessiable
AEHS ANNANDALE OFFICE is accessiable
AEHS FAIRFAX OFFICE is accessiable
CONCENTRA URGENT CARE - ALEXANDRIA is accessiable
CONCENTRA URGENT CARE - FAIRFAX is accessiable
MEDICAL ACCESS URGENT CARE - ALEXANDRIA is accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE - TYSONS is accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE-OLD TOWN is accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE-FALLS CHURCH is not accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE - FAIRFAX is accessiable
OAKTON URGENT CARE is accessiable
MCLEAN IMMEDIATE CARE FAMILY MEDICAL CENTER is accessiable
RESTON MEDICAL CENTER is accessiable
TYSONS CORNER MEDICAL CENTER is accessiable
OLD DOMINION URGENT CARE is not accessiable
NOVA PATIENT CARE - FALLS CHURCH is not accessiable
FAIRFAX URGENT CARE AND HEALTHPLEX is accessiable
MCLEAN MEDICAL CENTER is accessiable
ACE MEDICAL CARE is not accessiable
MILLENNIUM MEDICAL CARE - FAIRFAX is not accessiable
MILLENNIUM MEDICAL CARE - HERNDON is accessiable
PROGRESSIVE URGENT & PRIMARY CARE is accessiable
FAMILY IMMEDIATE CARE is accessiable
PEDIATRICS URGENT CARE - SPRINGFIELD is accessiable
PEDIATRICS URGENT CARE - HERNDON is accessiable
```

```python
quater_cursor = arcpy.da.SearchCursor (quater_join, ['DESCRIPTIO', 'ROUTE_NUMB', 'SHAPE_Leng'])
for row in quater_cursor:
    if row[2] != 0:
        print(row[0], 'is very accessiable' )
    elif row[2] == 0:
        print(row[0], "is not accessiable")
```

```
RESTON HOSPITAL CENTER is very accessiable
CENTREVILLE URGENT CARE is very accessiable
DOMINION HOSPITAL is not accessiable
INOVA FAIRFAX HOSPITAL is very accessiable
WALK IN MEDICAL CARE - BURKE is not accessiable
FORT BELVOIR COMMUNITY HOSPITAL is very accessiable
DOMINION URGENT CARE is very accessiable
INOVA EMERGENCY ROOM - RESTON/HERNDON is very accessiable
INOVA FAIR OAKS HOSPITAL is very accessiable
INOVA MOUNT VERNON HOSPITAL is very accessiable
INOVA URGENT CARE CENTER - CENTREVILLE is very accessiable
WALK IN MEDICAL CARE - FAIR OAKS is very accessiable
VUPC URGENT CARE is very accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE - LORTON is very accessiable
INOVA EMERGENCY ROOM - FRANCONIA/SPRINGFIELD is very accessiable
INOVA HEALTHPLEX LORTON is very accessiable
CAREMOW URGENT CARE - CENTREVILLE is very accessiable
CAREMOW URGENT CARE - CHANTILLY is very accessiable
PATIENT FIRST - CHANTILLY is very accessiable
PATIENT FIRST - ALEXANDRIA is very accessiable
INOVA URGENT CARE CENTER - RESTON is very accessiable
INOVA URGENT CARE CENTER - TYSONS is very accessiable
INOVA URGENT CARE CENTER - WEST SPRINGFIELD is very accessiable
INOVA URGENT CARE CENTER - VIENNA is very accessiable
AEHS ANNANDALE OFFICE is very accessiable
AEHS FAIRFAX OFFICE is not accessiable
CONCENTRA URGENT CARE - ALEXANDRIA is very accessiable
CONCENTRA URGENT CARE - FAIRFAX is not accessiable
MEDICAL ACCESS URGENT CARE - ALEXANDRIA is very accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE - TYSONS is very accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE-OLD TOWN is very accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE-FALLS CHURCH is not accessiable
ALLCARE FAMILY MEDICINE & URGENT CARE - FAIRFAX is very accessiable
OAKTON URGENT CARE is very accessiable
MCLEAN IMMEDIATE CARE FAMILY MEDICAL CENTER is very accessiable
RESTON MEDICAL CENTER is very accessiable
TYSONS CORNER MEDICAL CENTER is very accessiable
OLD DOMINION URGENT CARE is not accessiable
NOVA PATIENT CARE - FALLS CHURCH is not accessiable
FAIRFAX URGENT CARE AND HEALTHPLEX is very accessiable
MCLEAN MEDICAL CENTER is very accessiable
ACE MEDICAL CARE is not accessiable
MILLENNIUM MEDICAL CARE - FAIRFAX is not accessiable
MILLENNIUM MEDICAL CARE - HERNDON is very accessiable
PROGRESSIVE URGENT & PRIMARY CARE is very accessiable
FAMILY IMMEDIATE CARE is very accessiable
PEDIATRICS URGENT CARE - SPRINGFIELD is very accessiable
PEDIATRICS URGENT CARE - HERNDON is very accessiable
```

. The I ran a select tool (arcpy.anylsis.Select()) to select those facilites that are not accesible for each layer. We are able to detrmin that of the 48 medical facilites in Fairfax County, VA only 5 (10.4) medical facilities are not at least somewhat accessiable via bus (Figure 4). Of those 48 faciliteis 39 (81.25%) are classified as Very Accessable, 2 (4.16%) are classifed as accessible, and another 2(4.16%) are clasifed as Somewhat Accessiable.
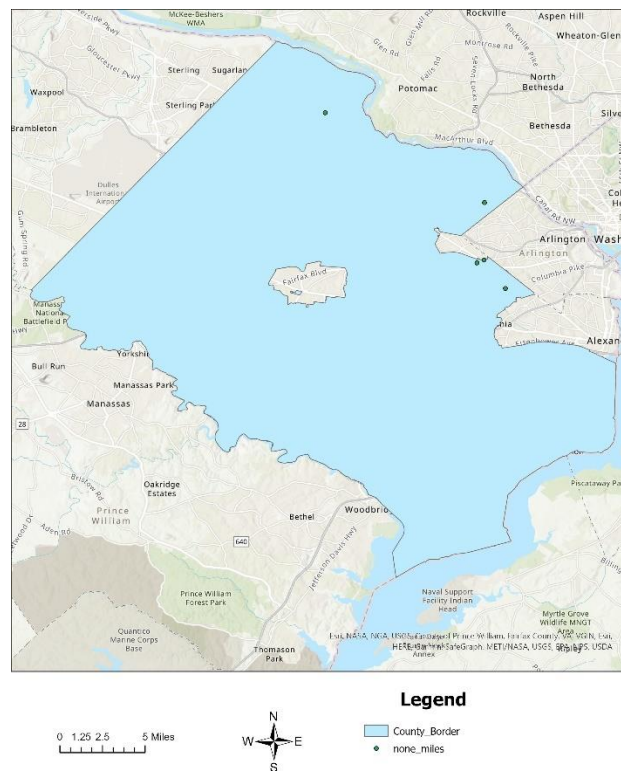
Discussion/Conclusion:

With just under 90% of the medical facilities in Fairfax County, VA it can be safely said that Fairfax has high accessibility to medical facilities via public transportation. Fairfax does have a couple of areas where accessibility is limited via bus, that being the northern most facility and

the four facilities that border Arlington VA. This gap in accessibility could be solved with the establishment of three or four new bus routes. This solutions should be relatively easy for the four facilities bordering Arlington since there are bus routes that go near these areas/ However the facility in the northern part of the county is a bit further out of the way of established bus routes.

There were a few limitations in this project that could have made it more robust. The addition of other forms of public transportation such as Metrorail and trolly services could have been included if access to accurate data was available. I would also like to have been able to utilize data on Arlington's bus data, because just like Fairfax's there is a chance that Arlington's bus routes may have crossed the county border and possible making 1 if not 4 of the medical facilities bordering Arlington fall into one of the accessible categories.

Developing a dataset for Arlington's data set as well as datasets for other forms of public transportation would be an excellent next step in furthering this project. This project is also a good jumping off point to write a larger project looking at medical accessibility via public transportation in major cities across the country.

References:

"County Border." *Fairfax County GIS & Mapping Services Open Data Site*, Fairfax County , data-fairfaxcountygis.opendata.arcgis.com/datasets/Fairfaxcountygis::county-border/explore. Accessed 18 Aug. 2023.

"Fairfax Connector System." *Fairfax County GIS & Mapping Services Open Data Site*, Fairfax County, data-fairfaxcountygis.opendata.arcgis.com/datasets/Fairfaxcountygis::fairfax-connector-system/explore. Accessed 18 Aug. 2023.

"Hospitals and Urgent Care Facilities." *Fairfax County GIS & Mapping Services Open Data Site*, Fairfax County, data-fairfaxcountygis.opendata.arcgis.com/datasets/Fairfaxcountygis::hospitals-and-urgent-care-facilities/explore. Accessed 18 Aug. 2023.