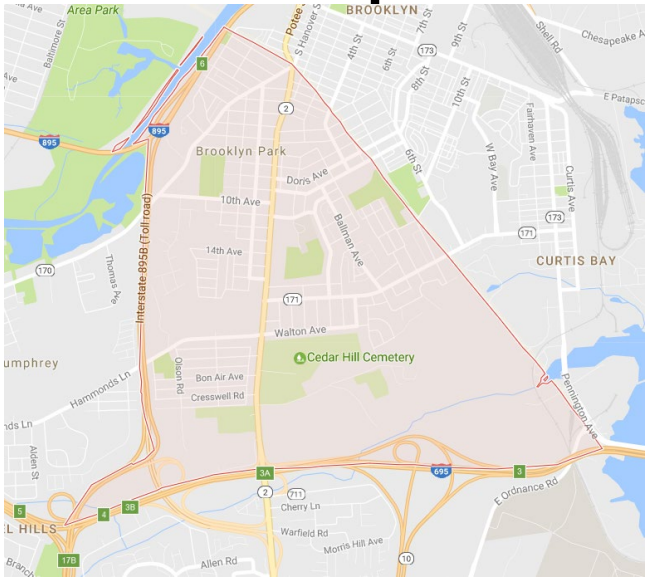
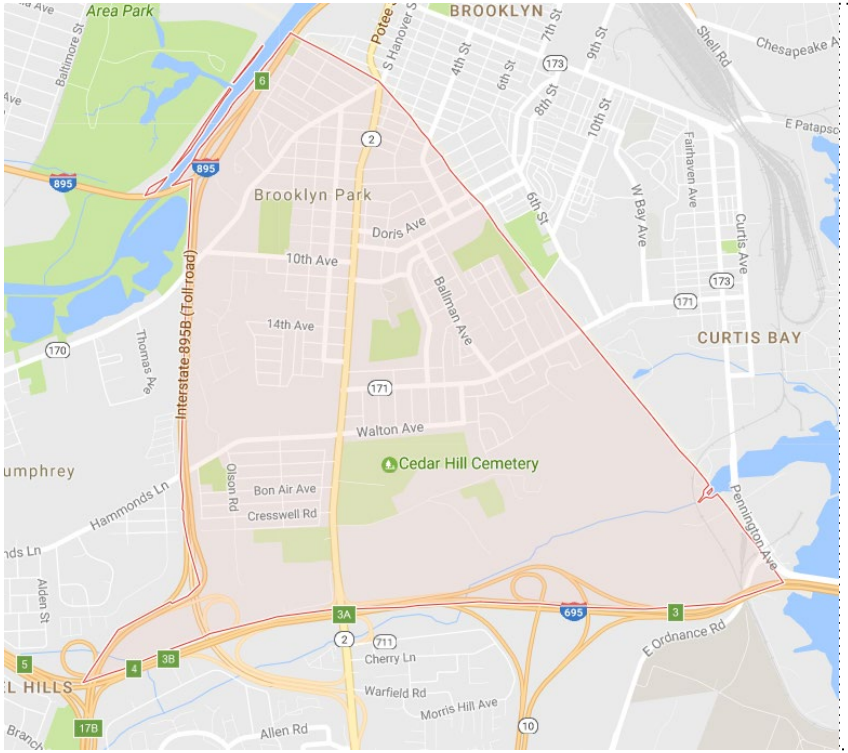
ENCE 472 Final Project:

Group 5



Transportation Alternatives for Brooklyn Park

Overview of Region



Transportation infrastructure

Surrounded by Interstates

MD Route 2 runs through center

MTA Route 014

AACC/Quarterfield to Patapsco Rail station

MTA Route 064

Riviera Beach to North Ave.

4.3 square miles

Problem Statement

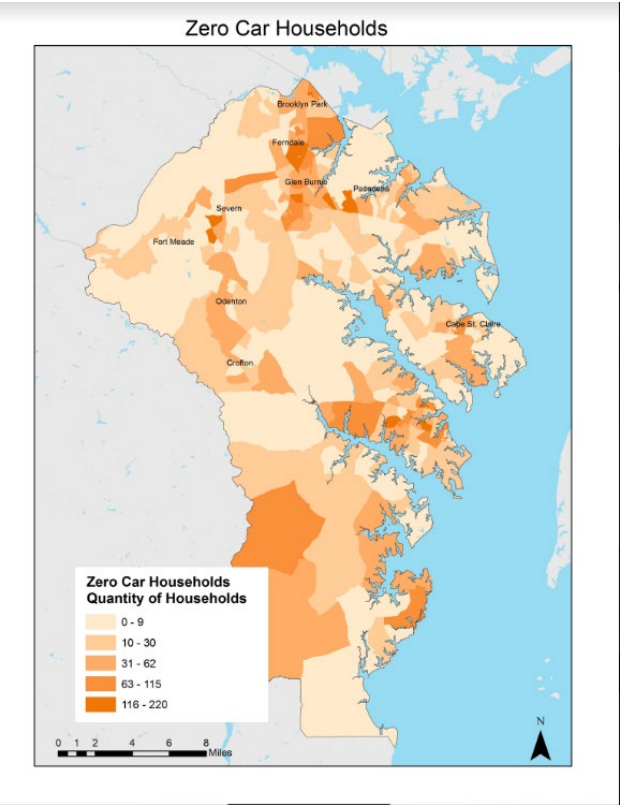
Brooklyn Park has extremely limited public transit

Many residents do not own a car

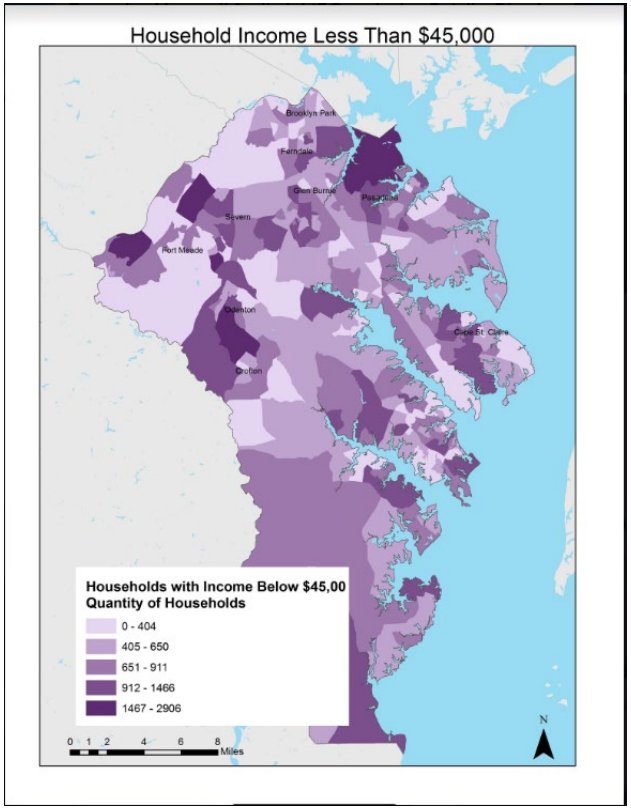
A new transit solution is required for those who live and work in the area

Limited infrastructure in Brooklyn Park to accommodate new forms of transit

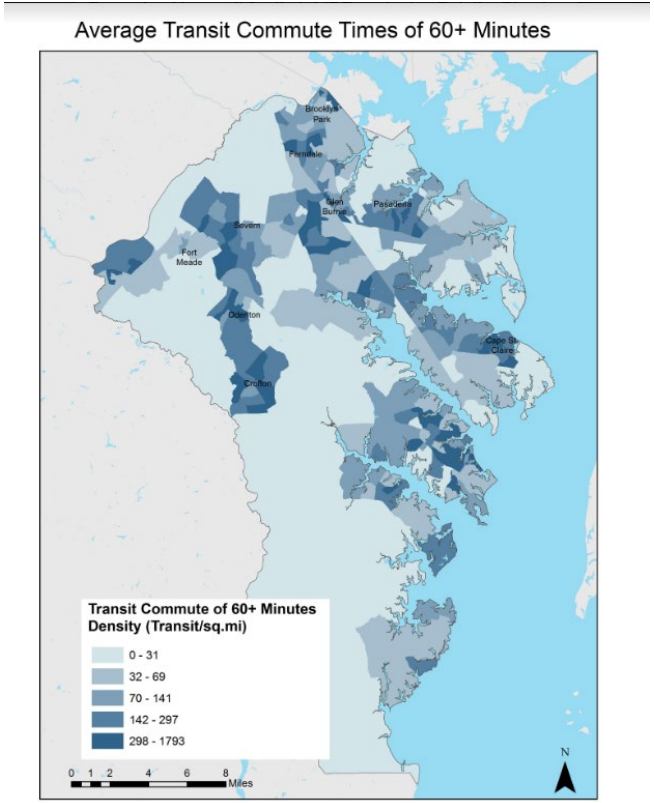
Existing Demographics



Household Income



Transit Commute Time



Review of Prior Work

Guidelines for Enhancing Suburban Mobility Using Public Transportation

Journal of Advanced Transportation

Demand-Responsive Transportation Systems and Services

A Guide for Planning and Operating Flexible Public Transportation Services

Integration of Fixed and Flexible Route Bus Systems

Method

Utilize academic studies written by Dr. Schonfeld and Dr. Chang

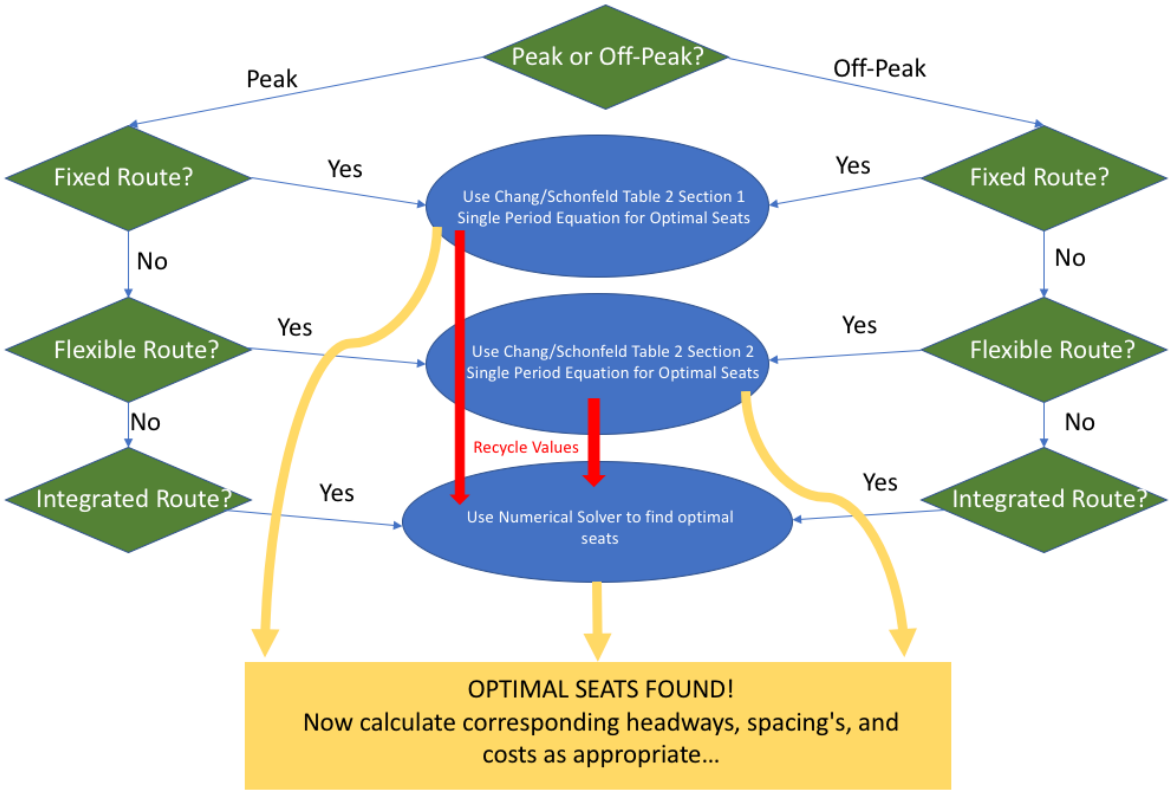
Develop alternatives -- fixed, flexible, and integrated routes

Test alternatives with academic data

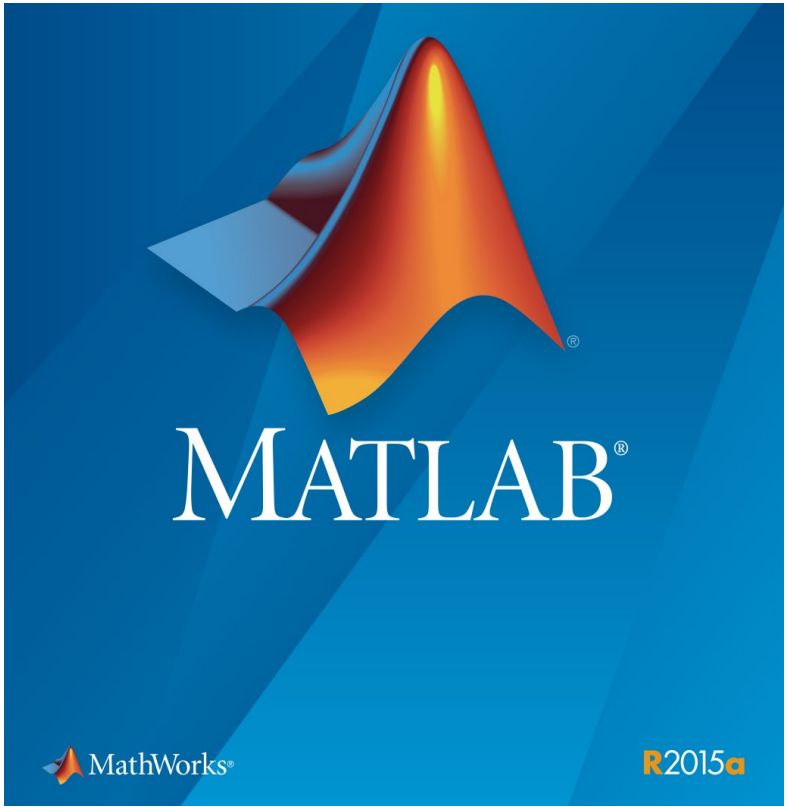
Run alternatives with real world inputs

Output optimal number of seats, total cost per route per day, spacing, service areas, and headways for either peak or off-peak hours

Model


Peak or Off-Peak?
Peak
Off-Peak
Fixed Route?
Yes
Use Chang/Schonfeld Table 2 Section 1 Single Period Equation for Optimal Seats
Yes
Fixed Route?
No
No
Flexible Route?
Yes
Use Chang/Schonfeld Table 2 Section 2 Single Period Equation for Optimal Seats
Yes
Flexible Route?
No
Recycle Values
No
Integrated Route?
Yes
Use Numerical Solver to find optimal seats
Yes
Integrated Route?
OPTIMAL SEATS FOUND!
Now calculate corresponding headways, spacing's, and costs as appropriate…

MATLAB DEMO



Results

```
Optimal Integrated Route during peak travel:
Total Daily Cost:          $5646.58 per day
Total Yearly Cost:        ~$1411645.44 per year
Fixed Route Spacing:        0.89581 miles
Flexible Zone Area:         1.5048 square miles
Headway (fixed route):      9.6747 minutes
Headway (flexible route):   8.6389 minutes
Number of Seats:            26 seats
```

```
Optimal Flexible Route during peak travel:
Total Daily Cost:          $5716.65 per day
Total Yearly Cost:        ~$1429162.15 per year
Flexible Zone Area:         1.2463 square miles
Headway (flexible route):   5.6237 minutes
Number of Seats:            36 seats
```

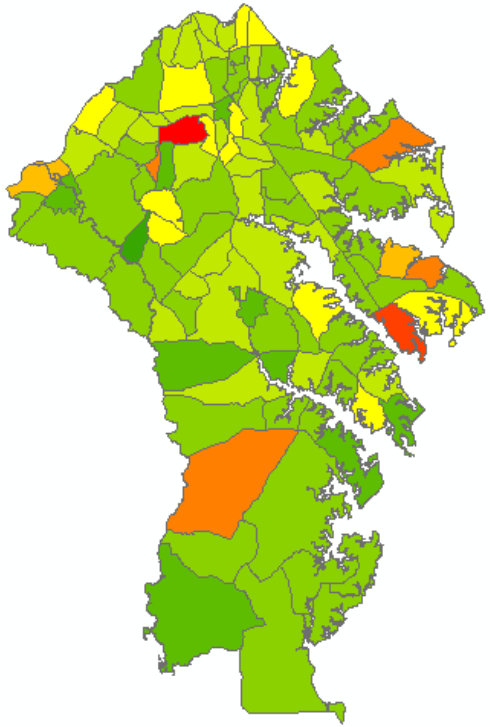
```
Optimal Fixed Route during peak travel:
Total Daily Cost:          $5732.93 per day
Total Yearly Cost:        ~$1433231.49 per year
Fixed Route Spacing:        0.93224 miles
Headway (fixed route):    11.1869 minutes
Number of Seats:            38 seats
```

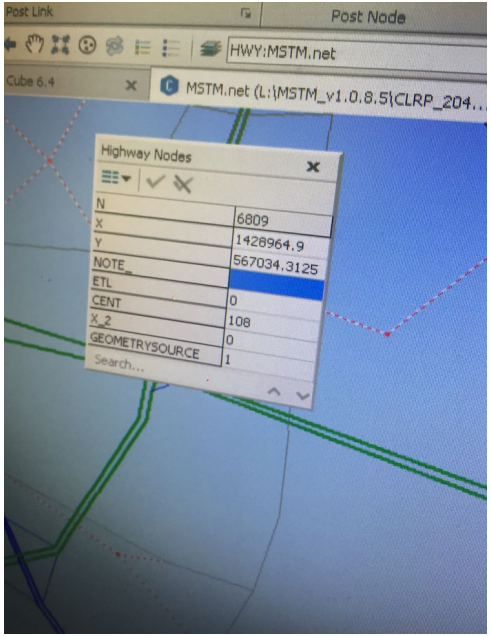
```
Optimal Integrated Route during off-peak travel:
Total Daily Cost:          $5646.58 per day
Total Yearly Cost:        ~$1411645.44 per year
Fixed Route Spacing:        0.89581 miles
Flexible Zone Area:         2.3888 square miles
Headway (fixed route):      9.6747 minutes
Headway (flexible route):   10.8843 minutes
Number of Seats:            26 seats
```

```
Optimal Flexible Route during off-peak travel:
Total Daily Cost:          $5716.65 per day
Total Yearly Cost:        ~$1429162.15 per year
Flexible Zone Area:         1.8891 square miles
Headway (flexible route):   6.46 minutes
Number of Seats:            31 seats
```

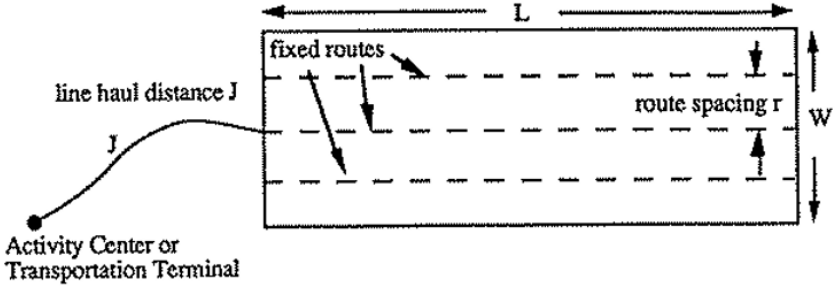
```
Optimal Fixed Route during off-peak travel:
Total Daily Cost:          $5732.93 per day
Total Yearly Cost:        ~$1433231.49 per year
Fixed Route Spacing:        1.1745 miles
Headway (fixed route):    14.0946 minutes
Number of Seats:            30 seats
```

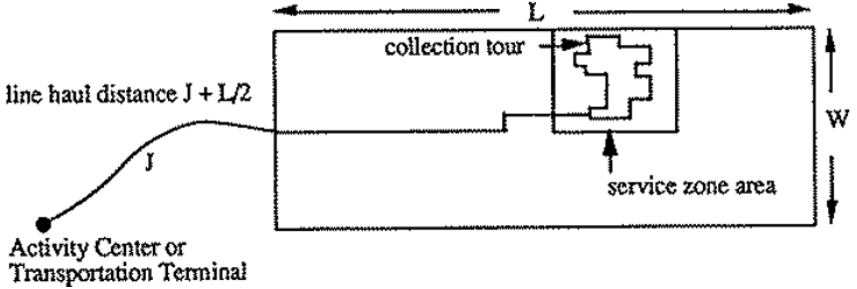
MSTM Changes





Recommendations : Integrated Route





Fixed-route service

Peak hour service (7AM-9AM, 4PM-6PM)

0.9 mile spacing

10 minute headways

Advantages

Flexible-route service

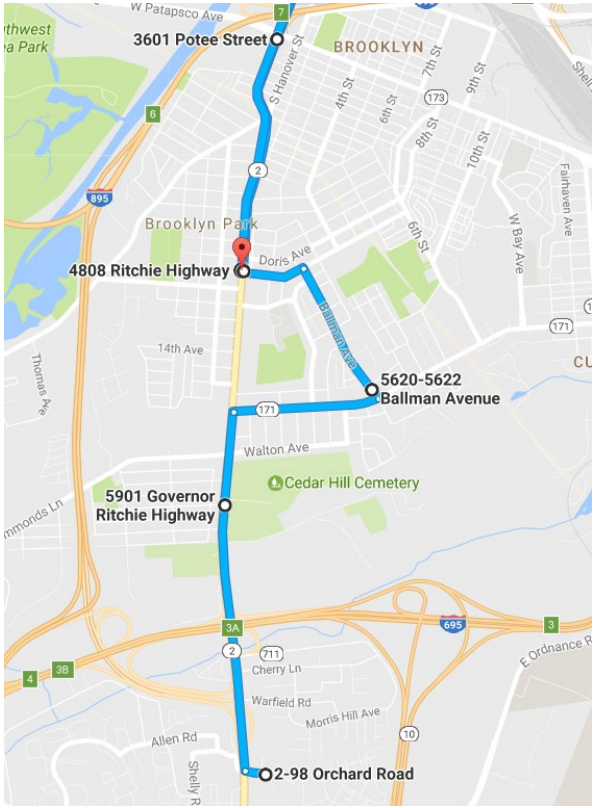
Off-Peak hour service (5AM-7AM, 9AM-4PM, 6PM-11PM)

2.5 square mile service zone

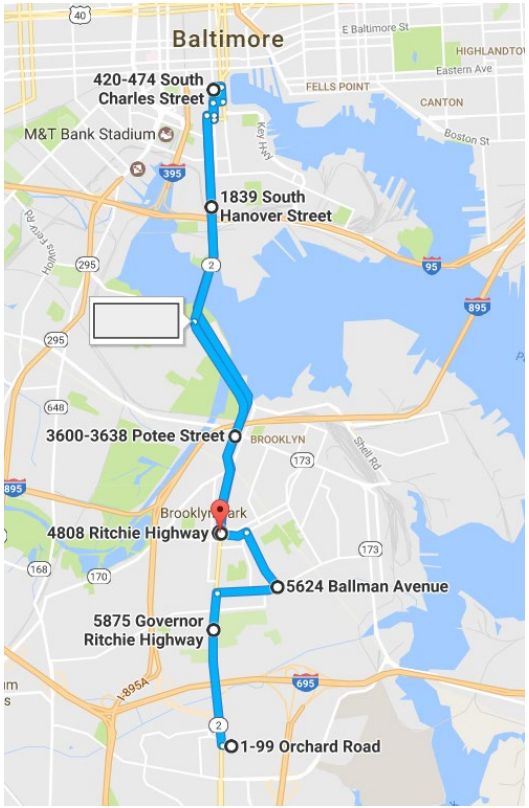
10.9 minute headways

Advantages

Peak Hours : Fixed-Route Service



- 4 stops throughout neighborhood
  - Spaced according to the ideal stop spacing (0.9 miles)
  - Overlap with MTA route 014 at intersection of MD Route 2 and Townsend Ave.
  - Overlap with MTA route 064 at intersection of MD Route 2 and Patapsco Ave.
- Route details
  - 45 minute round-trip time, 14.2 miles
  - Delay time of around 30



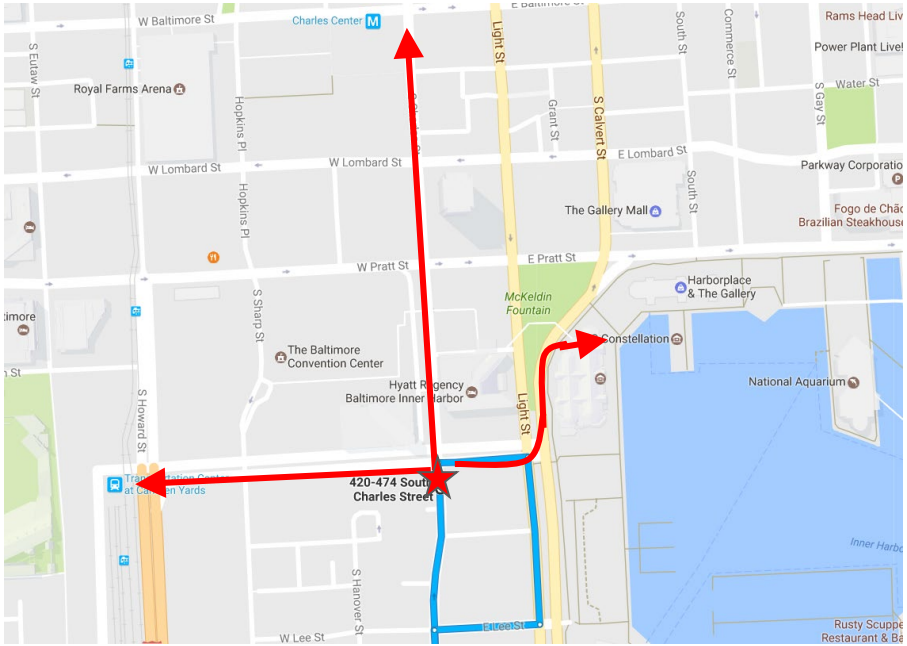
Peak Hours : Fixed-Route Service (cont'd)

Terminates at intersection of Charles St. and Conway St.

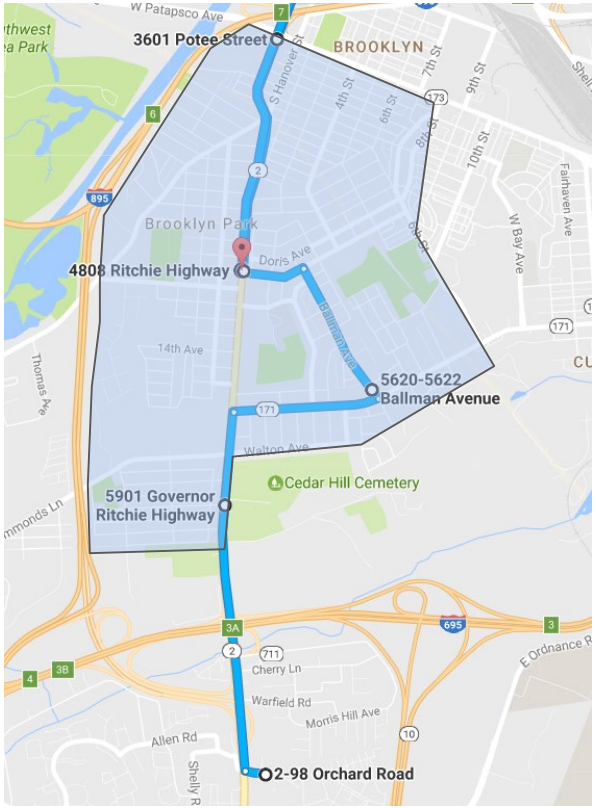
Alternative transportation options and attractions close

- Camden Yards Light Rail station (7 mins)
- Charles Center Station (9 mins)
- HarborPlace (7 mins)

Many employers within walking distance



Off-Peak Hours : Flexible-Route Service



Route Deviation strategy

- Same set route as fixed-route
- May deviate ¾ mile to serve pickup/drop-off requests
  - Call-in system
  - Mandated by ADA

Route details

- 45 minute round-trip times (variable depending on deviations)
- 11 minute headways

Infrastructure Requirements

Additional Bus pads, shelters, and
Bus Arrival System
recommended

Bus shelters ~$2,000 or more

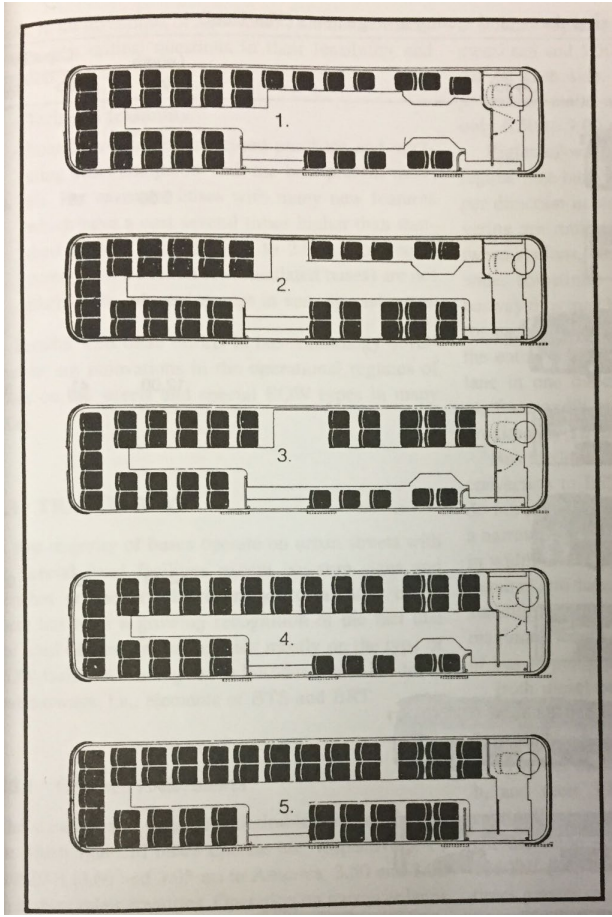
Complete Stop with pad ~$10,000[1]

Must be ADA compliant

1. "Heavy Duty Bus Smoking Steel Shelter Flat Roof 3-Sided Front Open 4' X 8' Bronze." *Material Storage Direct*. N.p., n.d. Web. 08 May 2017.
2. "Solar Bus Shelters From GoGreenSolar." *Gtm*. N.p., 10 Jan. 2011. Web. 08 May 2017.
3. Image on bottom right from google streetview

Bus Layout

From Vuchic Urban Transit and Development:



Plan number	Seats	Standing spaces	Total capacity
1	35	44	79
2	38	40	78
3	38	40	78
4	42	35	77
5	47	28	75

Environmental Impacts

Buses help to:

conserve energy - use 8.7% less energy per passenger mile than a typical automobile

reduce air pollution - emit only 20% as much carbon monoxide, 10% as many hydrocarbons, and 75% as many nitrogen oxides per passenger mile

Improve traffic flow - reduced number of vehicles on the road improves traffic conditions

Source: Delaware Division of Waste and Hazardous Substances

Cost of Operation

Total cost includes the capital cost of the buses, the bus drivers' salaries, gas cost, and user cost of time spent waiting and riding the bus

For the integrated routes:

Total daily operating cost - $5,646

Total yearly operating cost - $1,411,645.44

	Fixed	Flexible	Integrated
Total Daily Cost ($)	5,732.93	5,716.65	5,646.58
Total Yearly Cost ($)	1,433,231.49	1,429,162.15	1,411,645.44

W fset

Strengths/Weaknesses

Strengths

- Express bus
  - Currently faster than other transit options
- Cheap to implement
- Overlap with other forms of transportation
- Services area with potentially high demand

Weaknesses

- Demand had to be estimated (MSTM model was not as useful)
- One-dimensional solution

Conclusion

An integrated bus system is the most cost effective system while still servicing a majority of the community

Optimal routing system that can accommodate peak demand as well as lighter occupancy

Requires a minimum of capital investment on the county's part for facilities, drivers, and buses

Future Considerations

Expanding Model:

- Multiple periods of analysis
- More accurately simulate demand
- Utilize real world statistics
- Addition of a graphical output
- Addition of GUI
- Calculation of recommended fares as a model output

Further Study:

- Utilize more updated model
- Pull more data from MSTM
- Research updated cost figures
- Utilize AA County Statistical data
- Research alternative forms of transit such as ridesharing, light rail, and cycling

QUESTIONS ?