

Dave Faucett
GIS Analyst

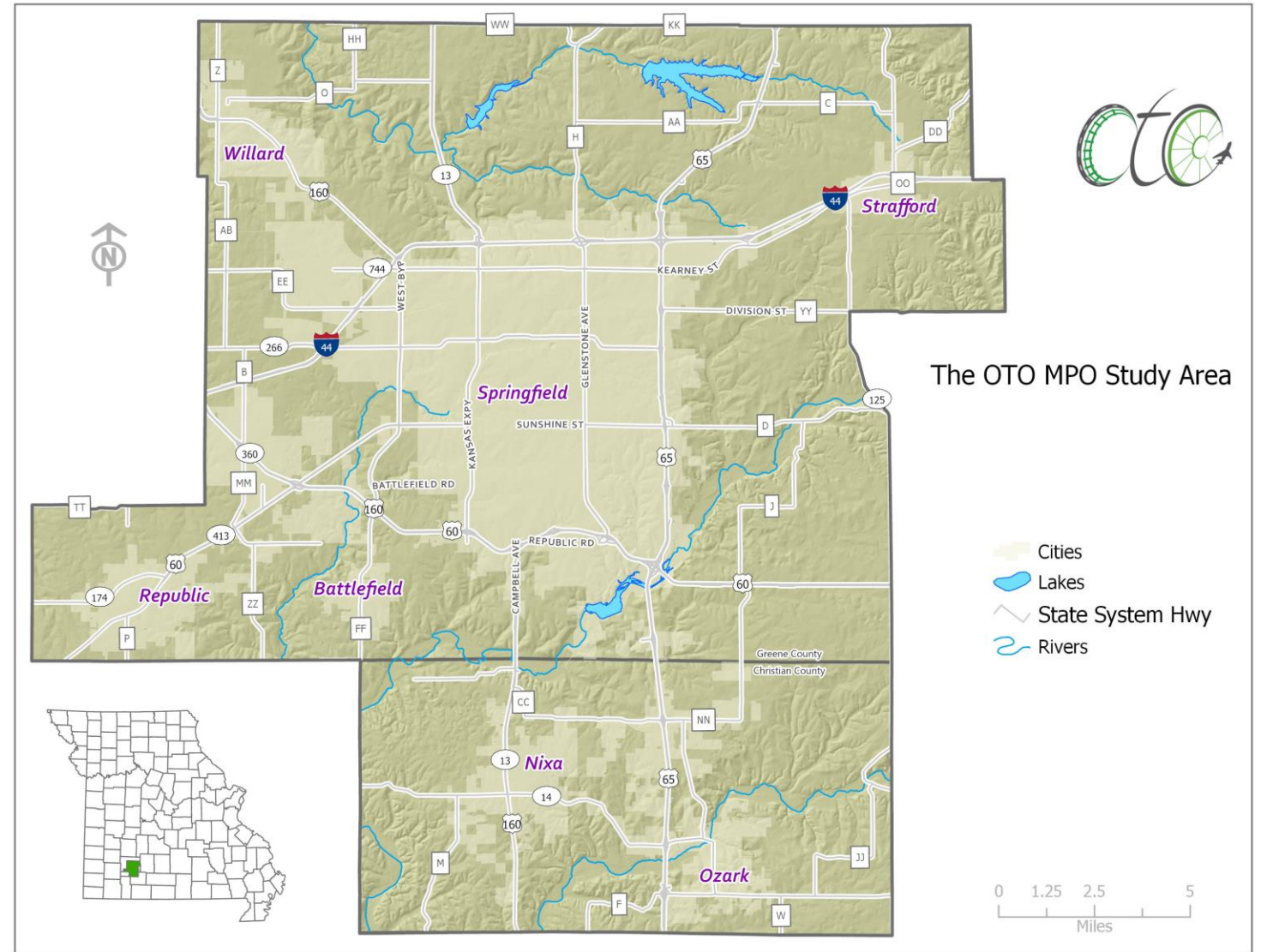
The Ozarks Transportation
Organization



Adding Google Transit Feed Specification (GTFS) Tables for Multi-Modal Network Analysis of Transit Accessibility

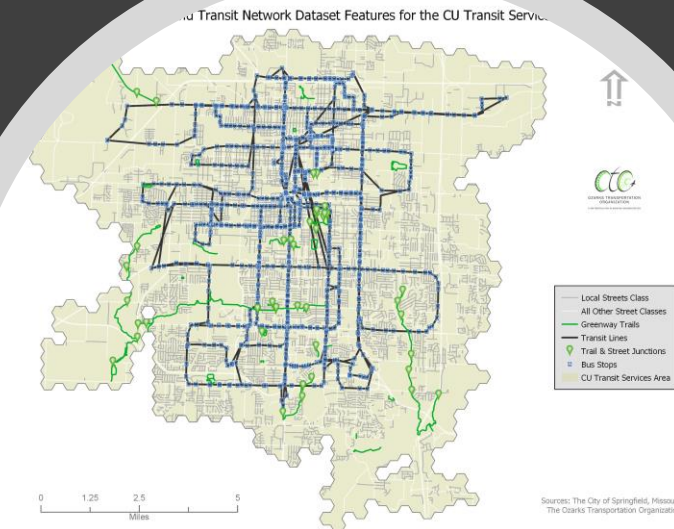
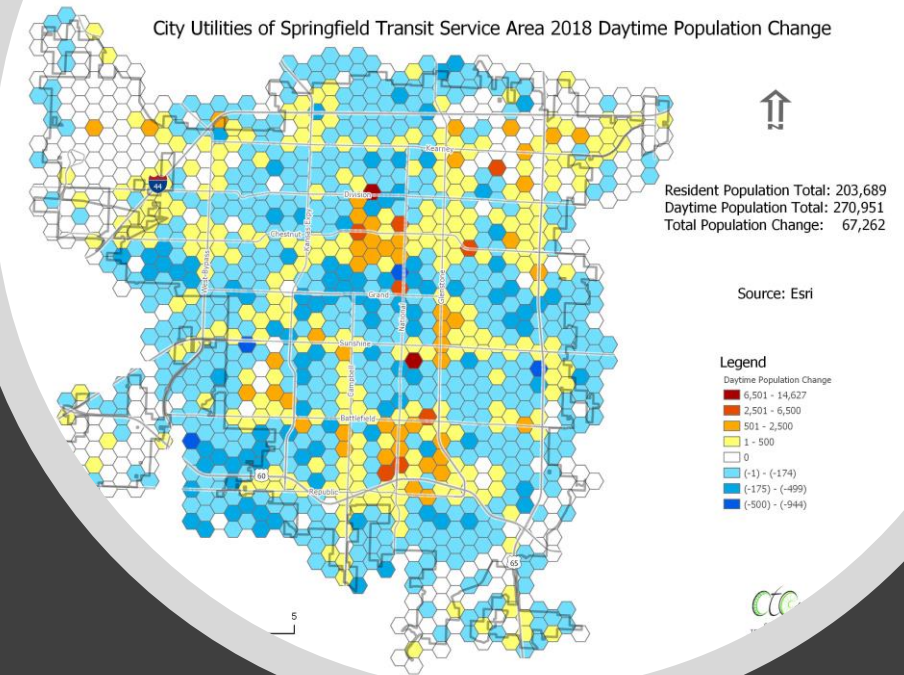
Ozarks Transportation Organization MPO

- Federally Designated Transportation Planning Organization for Springfield, MO Metro Area
- MPO 2017 Population Estimate - 329,330
- Support Transit Services Planning of Route and Schedule Alternatives



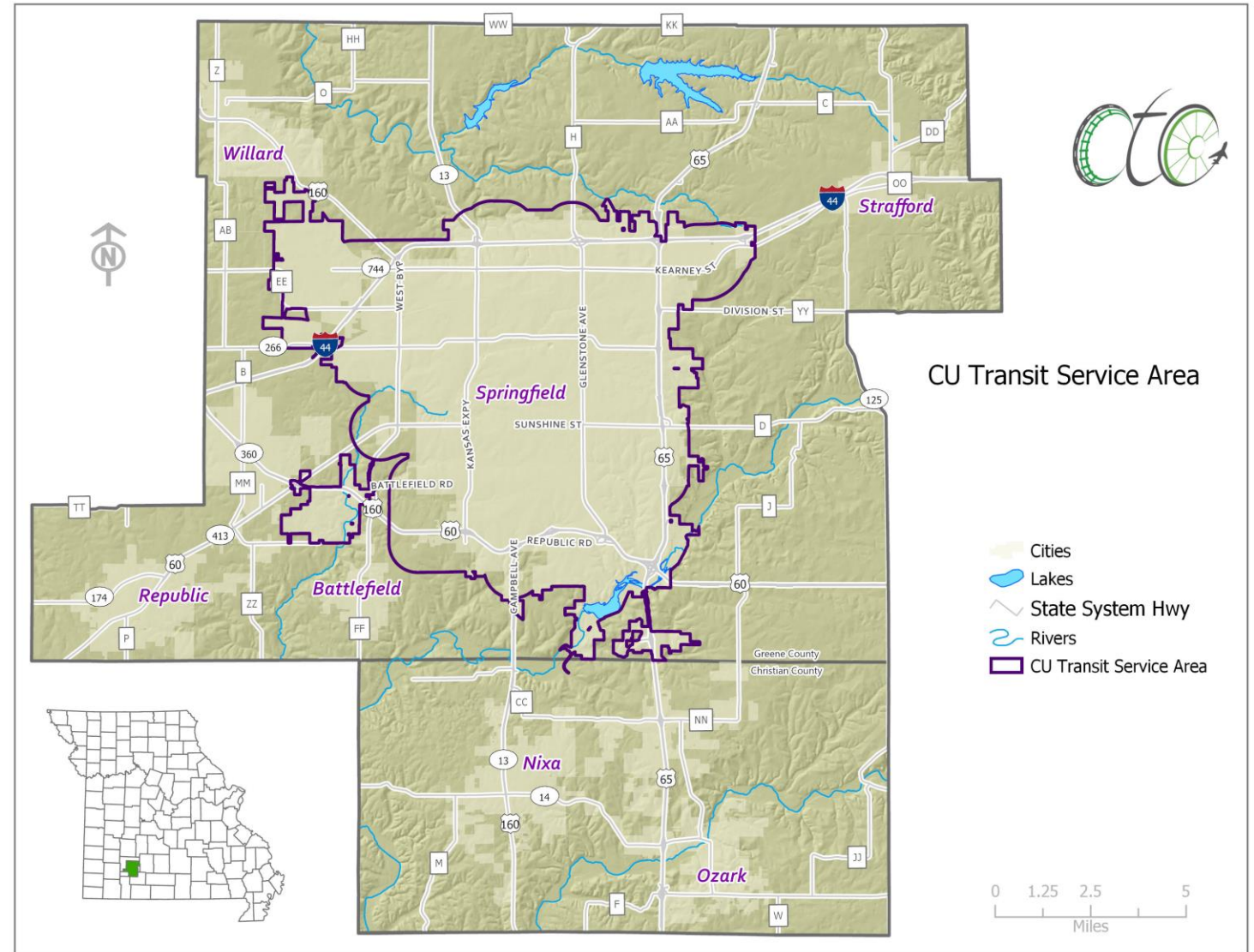
Origin/Destination Study for Transit

- Transit Accessibility
- Accessibility - the ease of getting from place to place
- Measured in distance or time
- Transportation Network
- Activity Element



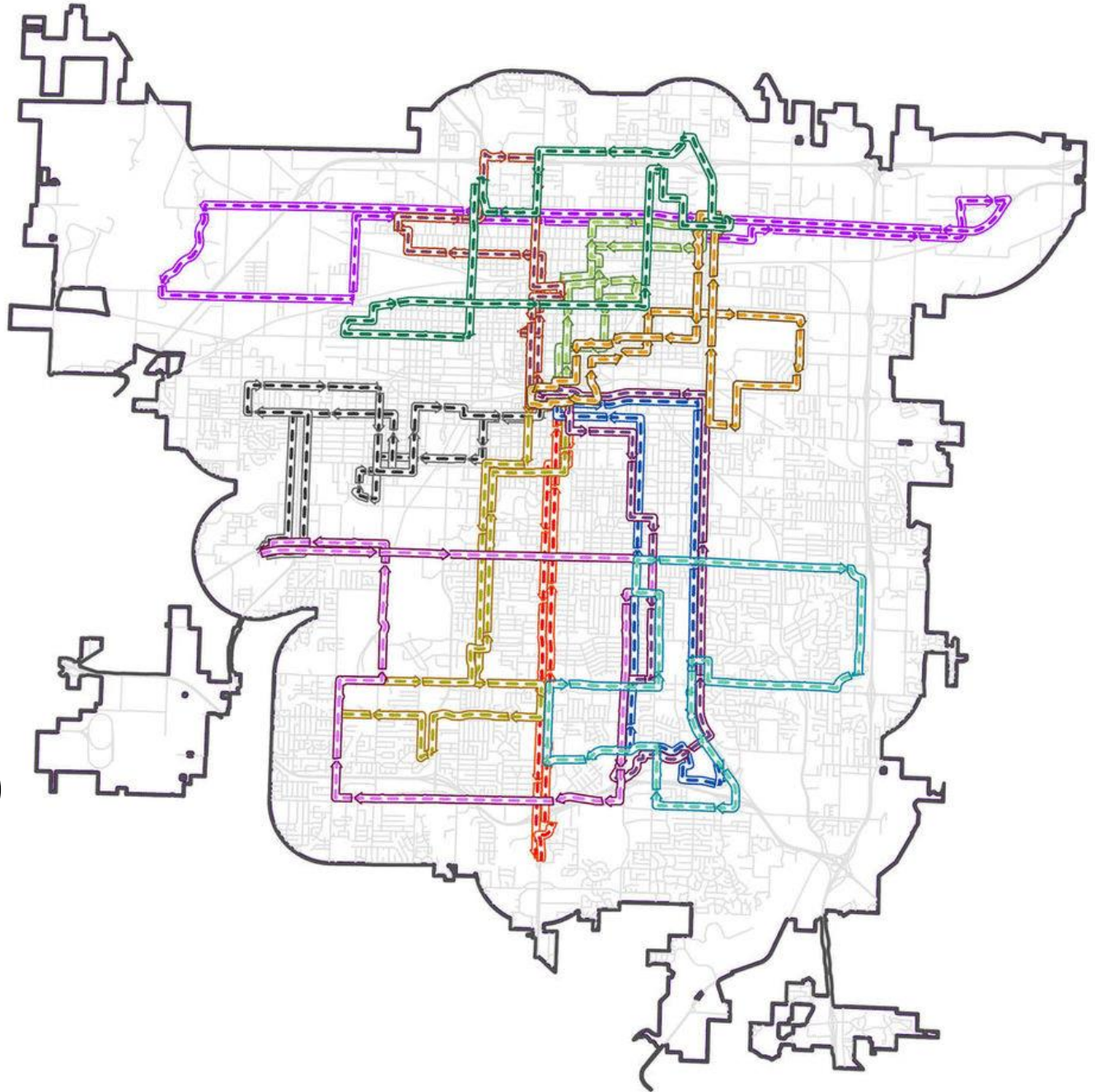
City Utilities Of Springfield Transit Services

- Service Area covers 95 square miles and includes Springfield city limits
- Plus outlying areas within 3/4s of a mile from existing routes
- Bus service operates 365 days per year



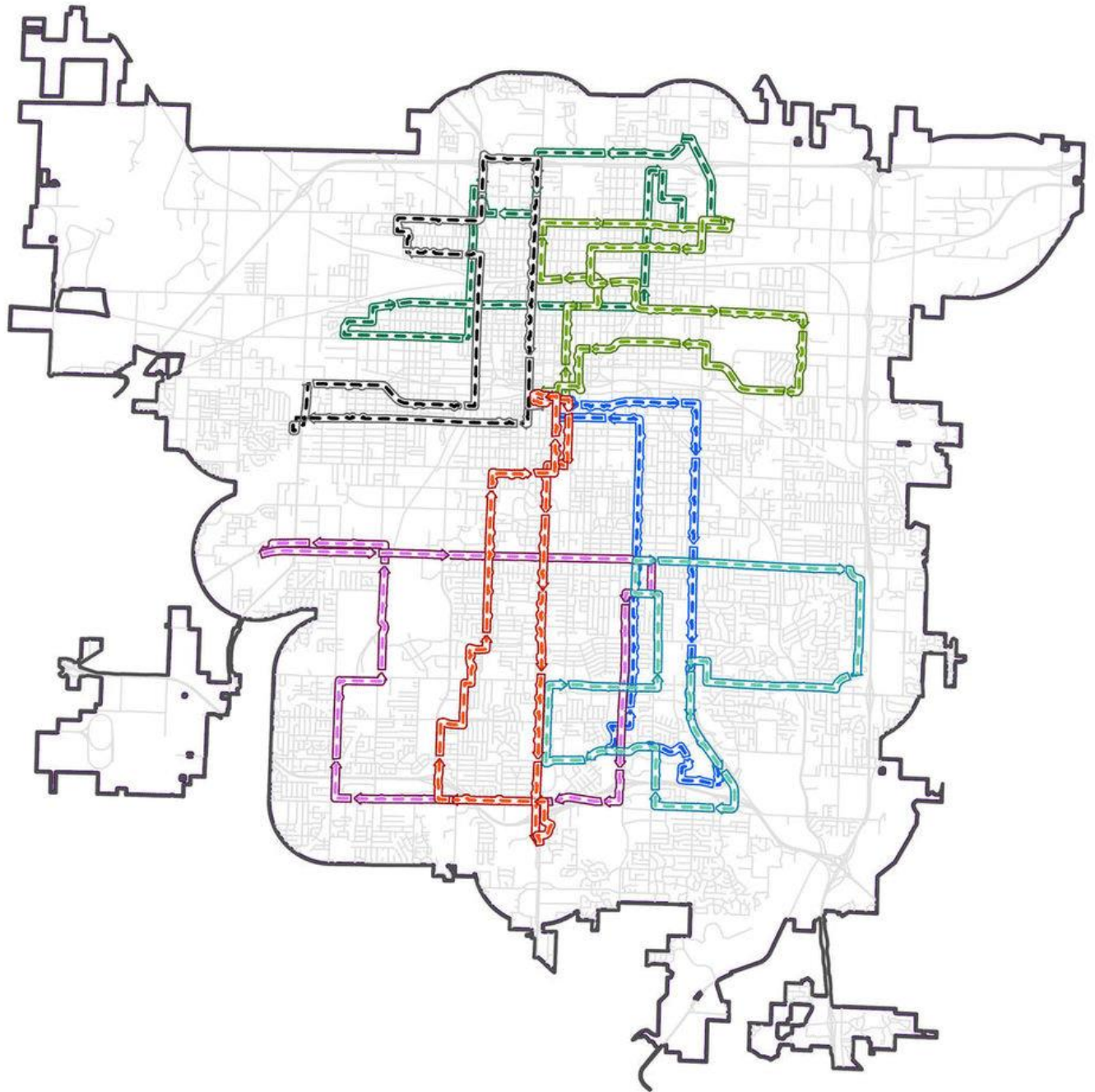
Weekday Day Routes

- 12 Routes
- One-hour headways (6 Routes)
- 30 minute headways (6 Routes)

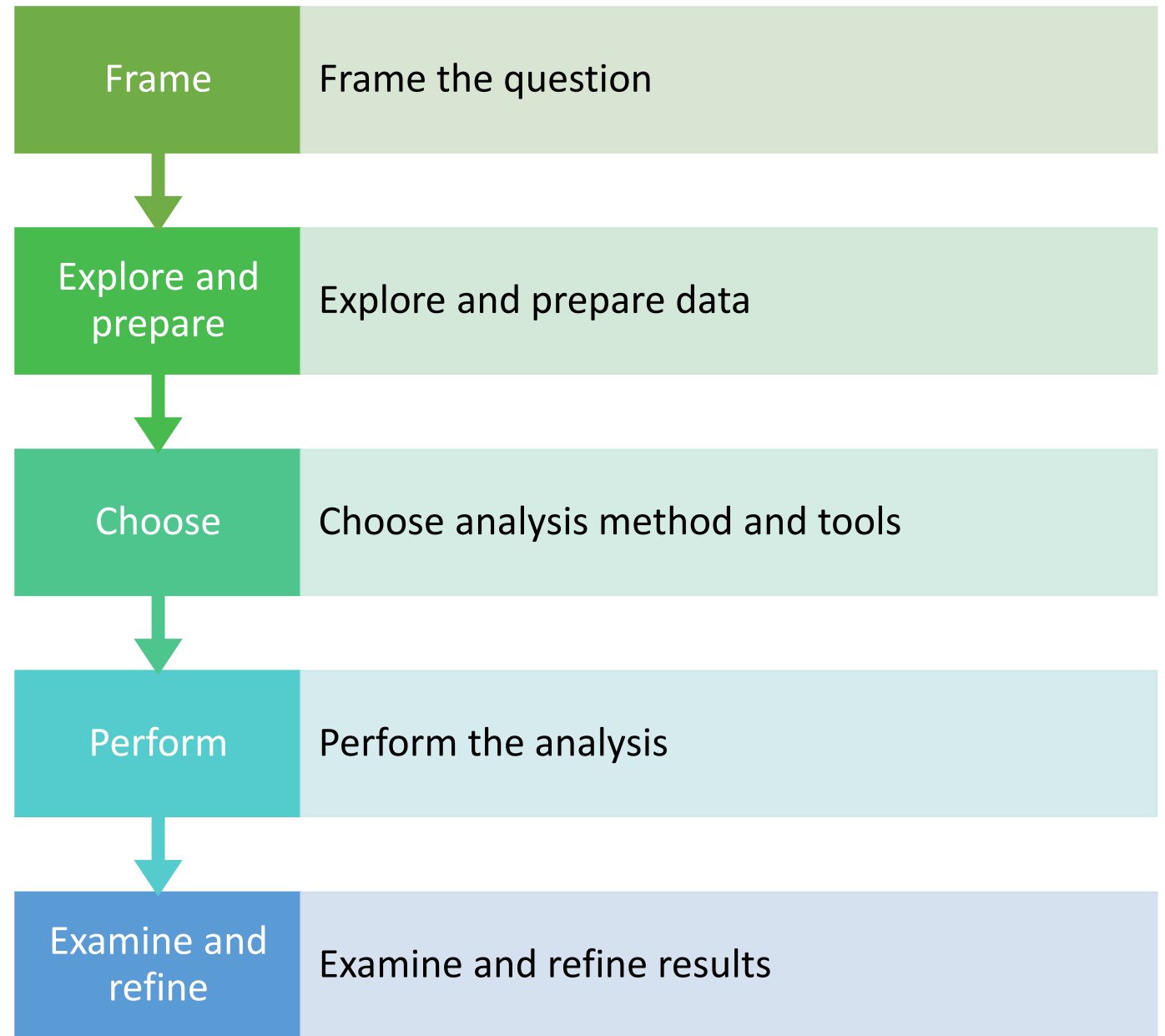


Weekday Night Routes

- 7 Routes
- One-hour headways



GIS Analysis Workflow



Frame the Question

How well does transit service connect riders to major daytime activity centers in the CU Transit Service area?

What is the demographic composition of people in locations that have the greatest and least transit access to activity centers?

Are there more efficient route and schedule alternatives to connect people to activities via transit in the service area?

Explore and
Prepare Data

Origins &
Destinations

LEHD LODES Data

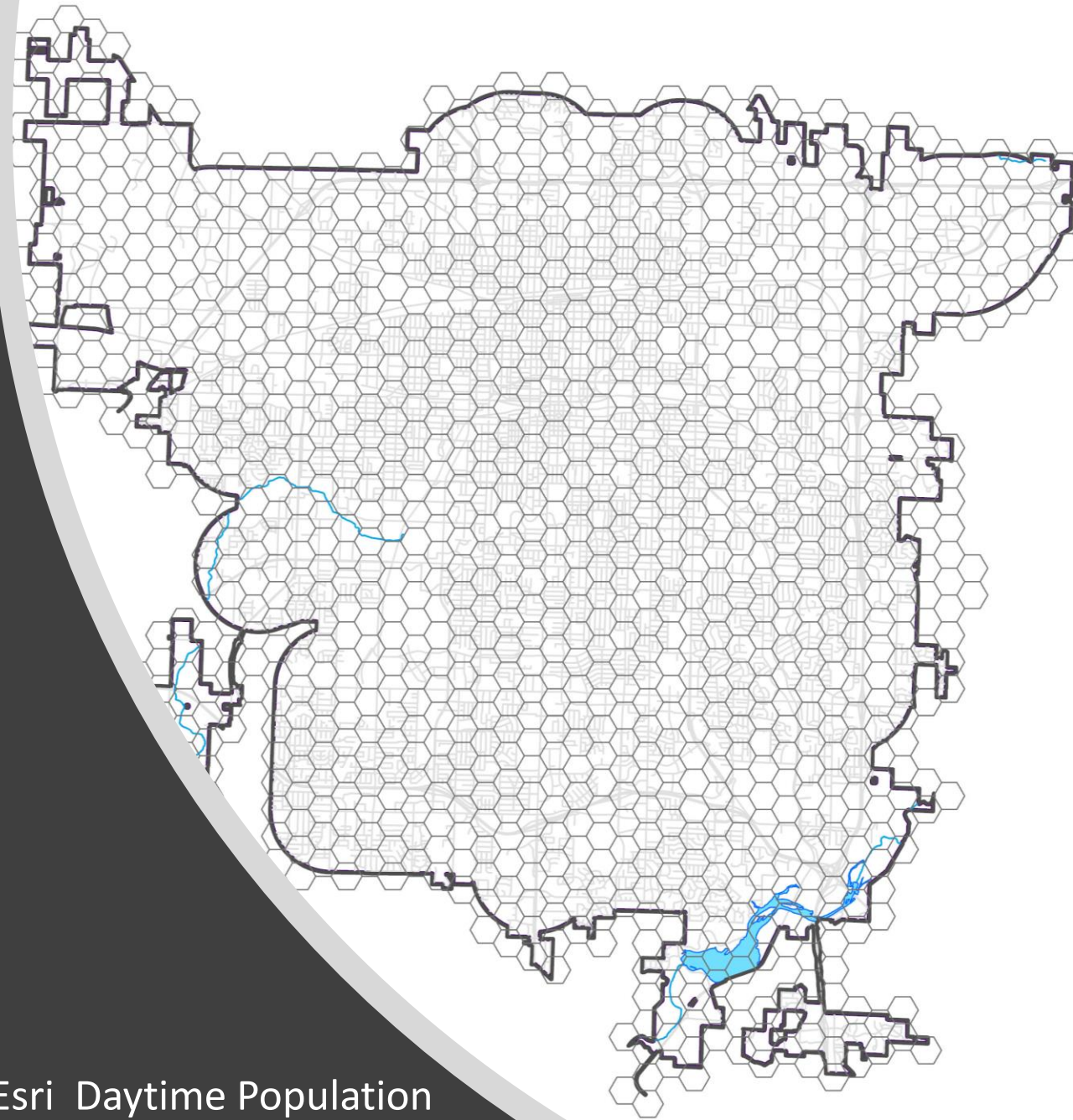
Census Blocks

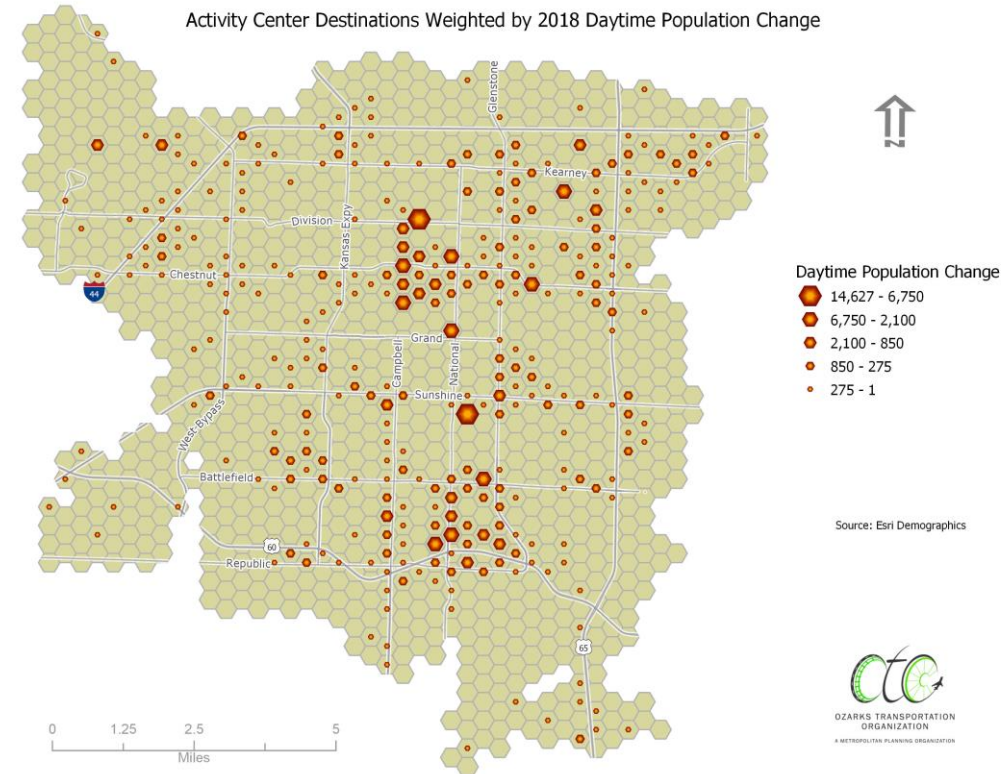
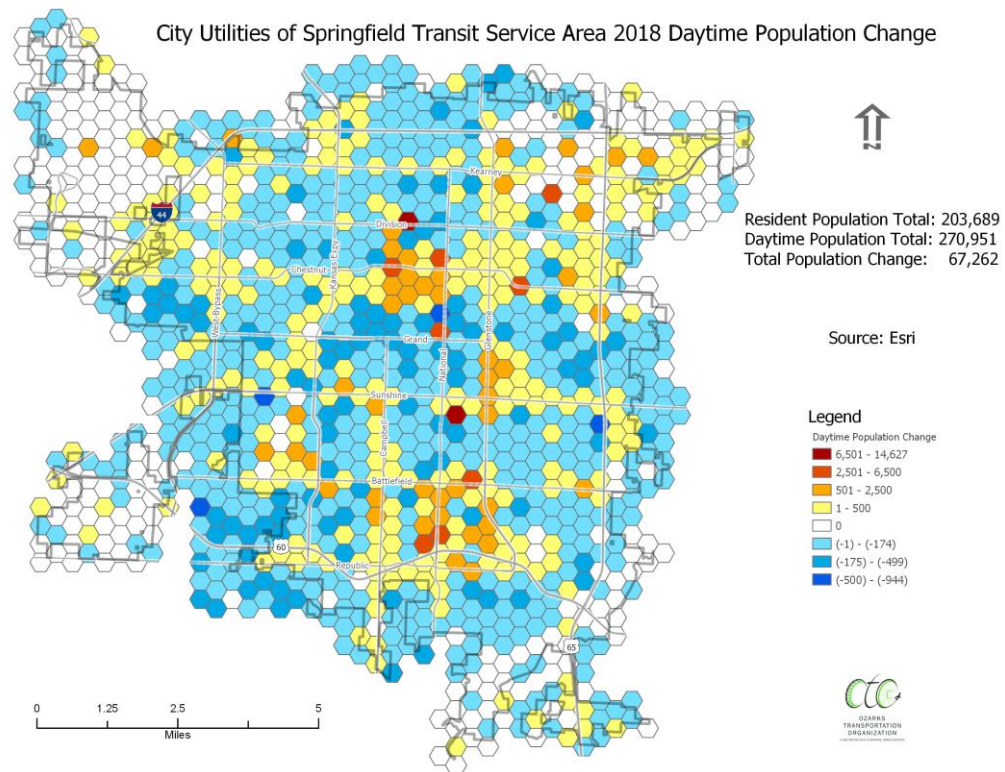
American Community Survey

ArcGIS Online

Destinations: Enriched Hex Bins

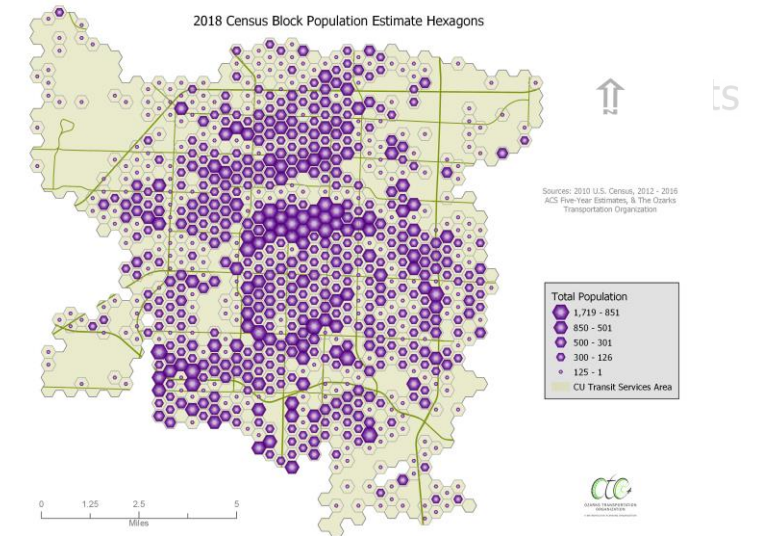
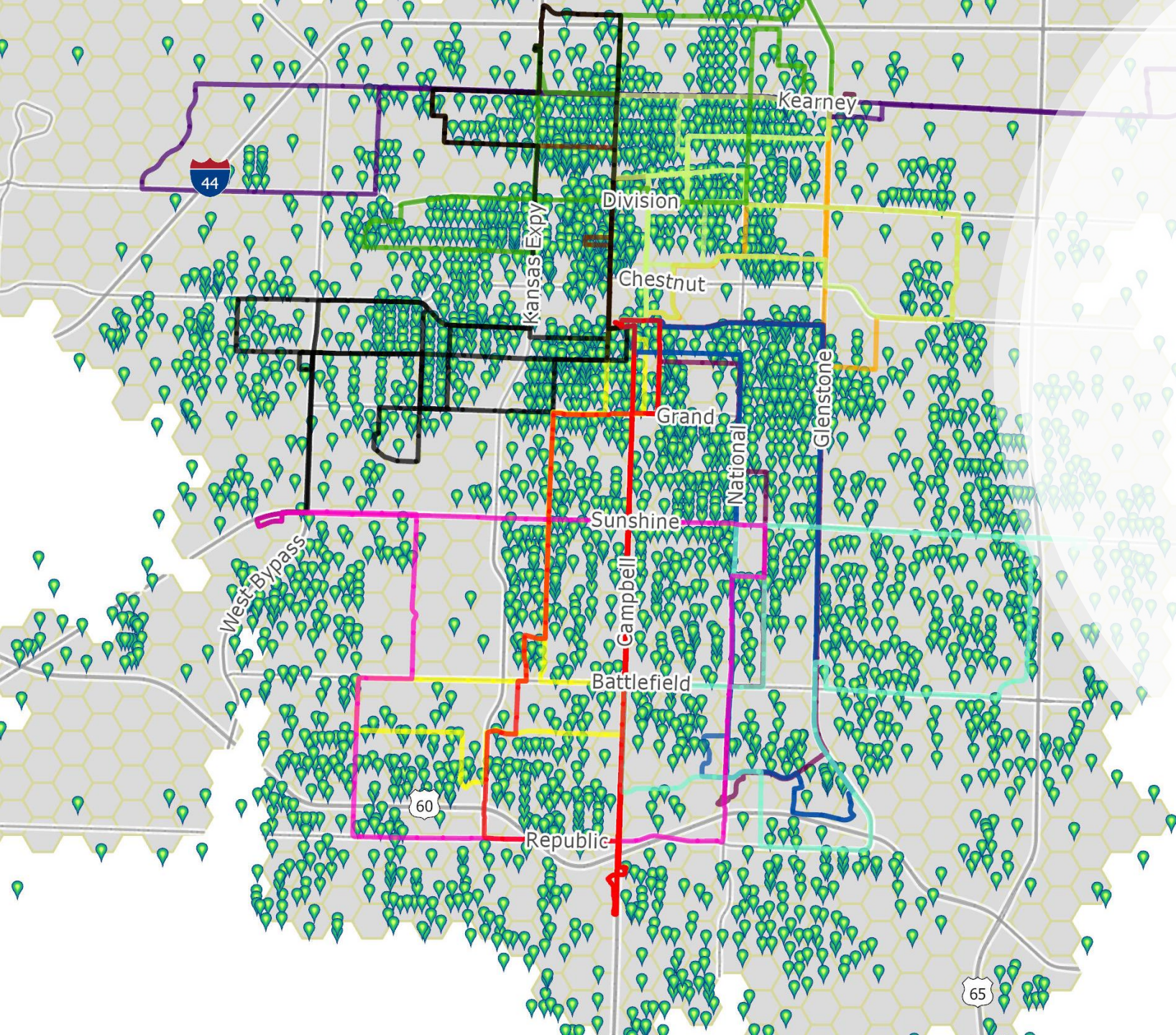
- Generate Tessellation
- 1,178 1/10th Square Mile Hexagons
- 10 credits per 1,000 attributes
- Enriched in ArcGIS Online with Esri 2018 population & Esri Daytime Population





Activity Centers

Estimating 2018 Census Block Demographics



- NE Lime
- Natl/Glenstone Maroon
- Industrial Express Purple
- Glenstone/National Blue
- Fort Yellow
- Division Orange
- Dale Lime
- College Black
- Campbell Red

2012 – 2016 ACS Five-Year Variables Estimated for Census Blocks

((2010 Census Block Housing Units +
Residential Units added 2011 – 2017)
– ACS 2016 %Vacant Units) * 2010
Census Block Avg. HH Size =
2018 Population Estimates

- Number of Workers by Age Group
- People Living in \$0 to \$24,999 Income Households
- People Living in \$25,000 to \$49,999 Income Households
- People Living in \$50,000 to \$74,999 Income Households
- People Living in \$75,000 and greater Income Households
- Number of Workers by Industry
- Means of Transportation to Work
- Travel Time to Work
- Time Leaving for Work
- Number of Household Vehicles Available

Explore and
Prepare Data

Transportation
Elements

Bus
Routes &
Stops

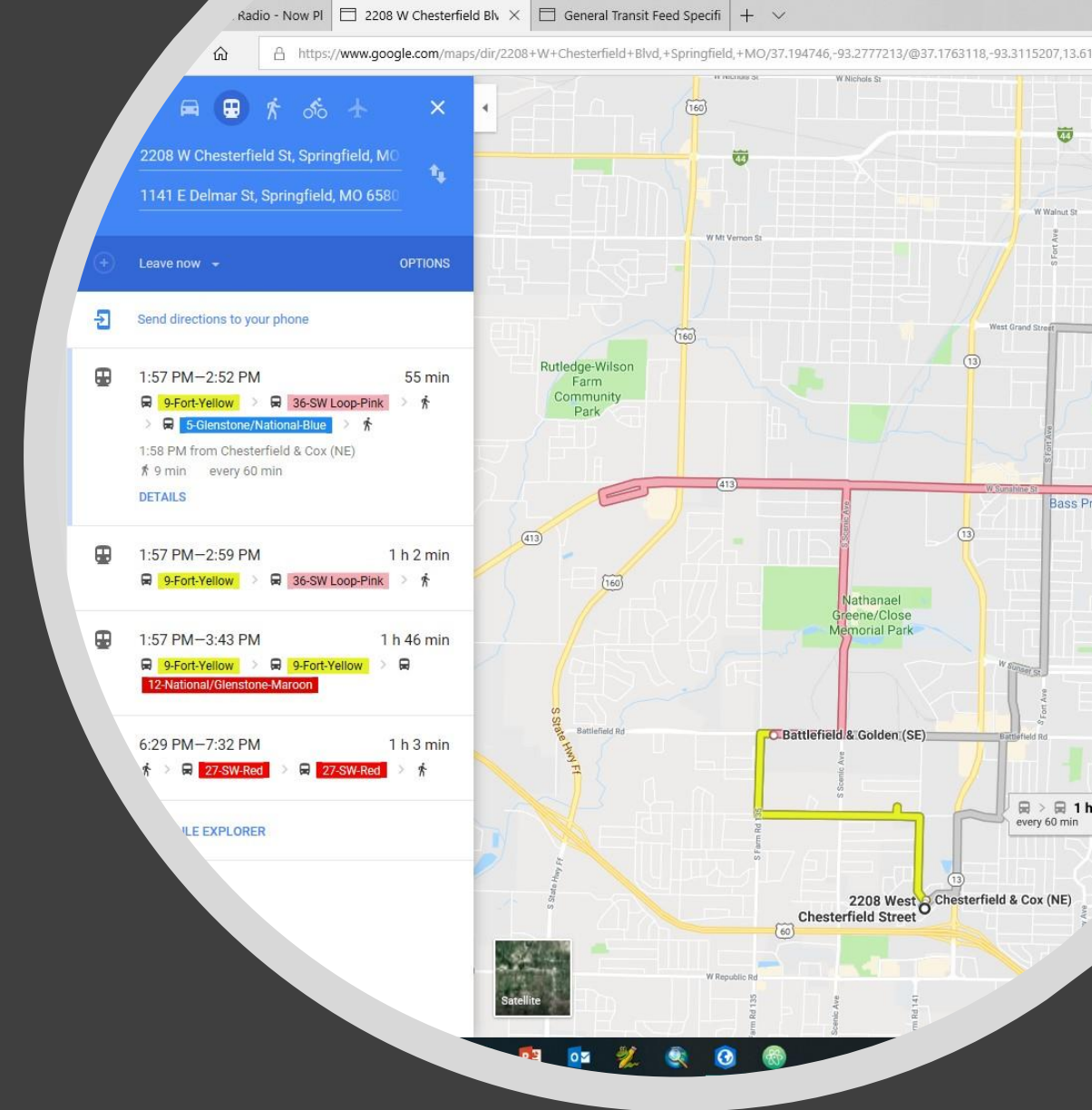
Sidewalks

Street
Centerline

Greenway
Trails

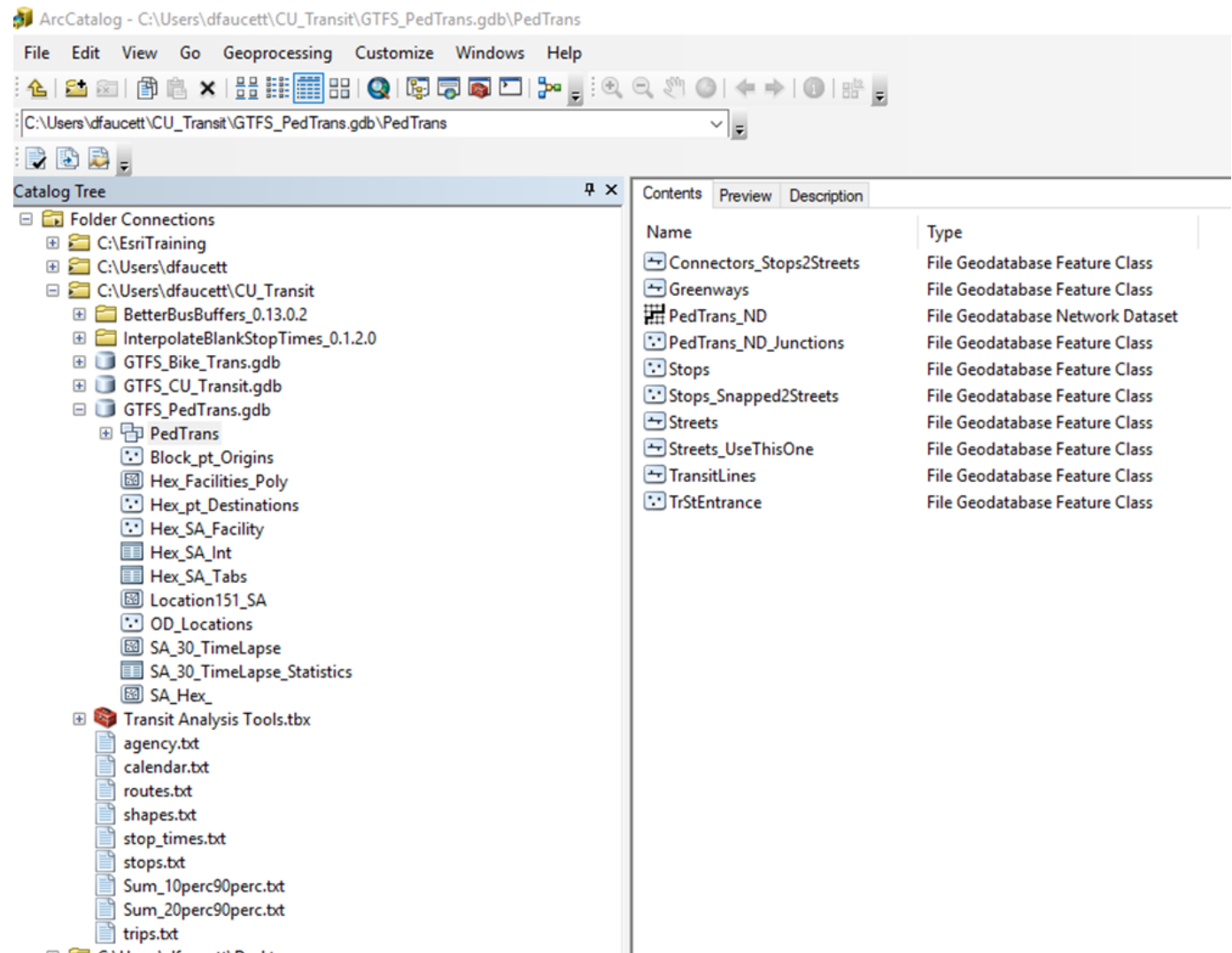
Google Transit Feed Specification Tables

- agency.txt
- calendar.txt
- routes.txt
- shapes.txt
- stop_times.txt
- stops.txt
- trips.txt



Adding GTFS Data for Multi-Modal Network Analysis

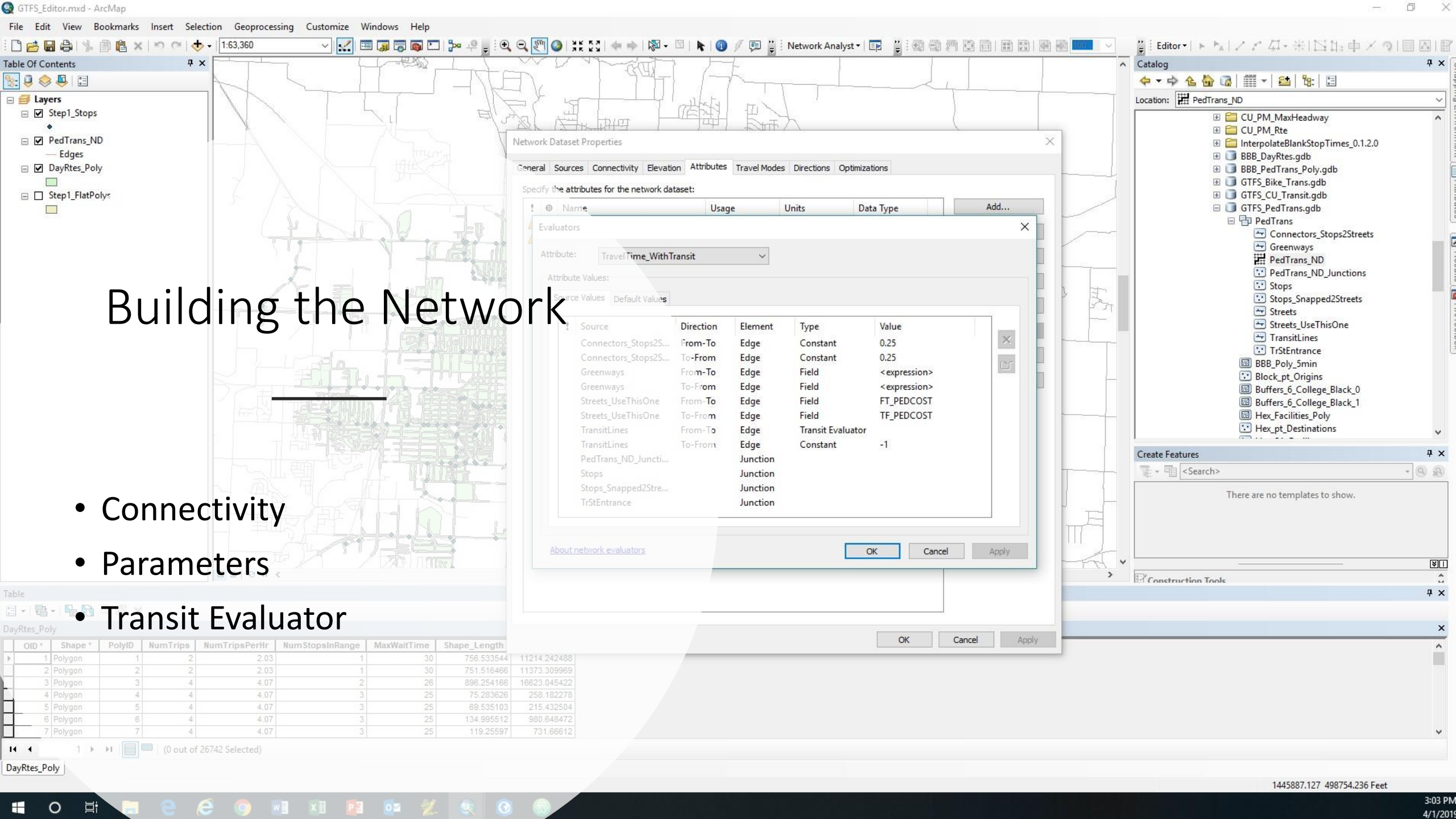
- Generate Transit Lines & Stops
- Generate Stop Street Connectors
- Get Network IDs
- esri.github.io/public-transit-tools/AddGTFSStoaNetworkDataset.html



Connectivity Parameters Transit Evaluator

- Connectivity
- Parameters
- Transit Evaluator

OK	Cancel	Apply	8	Sum ca03_2018	Sum Pop_under_25k_HH
2	0	1	1	1	1
4	0	1		3	3
1	0	1		0	0



Building the Network

- Connectivity
- Parameters
- Transit Evaluator

Table

	OID *	Shape *	PolyID	NumTrips	NumTripsPerHr	NumStopsInRange	MaxWaitTime	Shape_Length	
	1	Polygon	1	2	2.03	1	30	756.533544	11214.242488
	2	Polygon	2	2	2.03	1	30	751.516466	11373.309969
	3	Polygon	3	4	4.07	2	26	896.254166	16623.045422
	4	Polygon	4	4	4.07	3	25	75.283626	258.182278
	5	Polygon	5	4	4.07	3	25	69.535103	215.432504
	6	Polygon	6	4	4.07	3	25	134.995512	980.648472
	7	Polygon	7	4	4.07	3	25	119.25597	731.66612

DayRtes_Poly

(0 out of 26742 Selected)

Network Dataset Properties

General Sources Connectivity Elevation Attributes Travel Modes Directions Optimizations

Specify the attributes for the network dataset:

Name	Usage	Units	Data Type	Add...
Evaluators				
Attribute: TravelTime_WithTransit				
Attribute Values:				
Source Values	Default Values			
Source	Direction	Element	Type	Value
Connectors_Stops2S...	From-To	Edge	Constant	0.25
Connectors_Stops2S...	To-From	Edge	Constant	0.25
Greenways	From-To	Edge	Field	<expression>
Greenways	To-From	Edge	Field	<expression>
Streets_UseThisOne	From-To	Edge	Field	FT_PEDCOST
Streets_UseThisOne	To-From	Edge	Field	TF_PEDCOST
TransitLines	From-To	Edge	Transit Evaluator	
TransitLines	To-From	Edge	Constant	-1
PedTrans_ND_Juncti...		Junction		
Stops		Junction		
Stops_Snapped2Stre...		Junction		
TrStEntrance		Junction		

OK Cancel Apply

Editor

Catalog

Location: PedTrans_ND

- CU_PM_MaxHeadway
- CU_PM_Rte
- InterpolateBlankStopTimes_0.1.2.0
- BBB_DayRtes.gdb
- BBB_PedTrans_Poly.gdb
- GTFS_Bike_Trans.gdb
- GTFS_CU_Transit.gdb
- GTFS_PedTrans.gdb
- PedTrans
 - Connectors_Stops2Streets
 - Greenways
 - PedTrans_ND
 - PedTrans_ND_Junctions
 - Stops
 - Stops_Snapped2Streets
 - Streets
 - Streets_UseThisOne
 - TransitLines
 - TrStEntrance
- BBB_Poly_5min
- Block_pt_Origins
- Buffers_6_College_Black_0
- Buffers_6_College_Black_1
- Hex_Facilities_Poly
- Hex_pt_Destinations

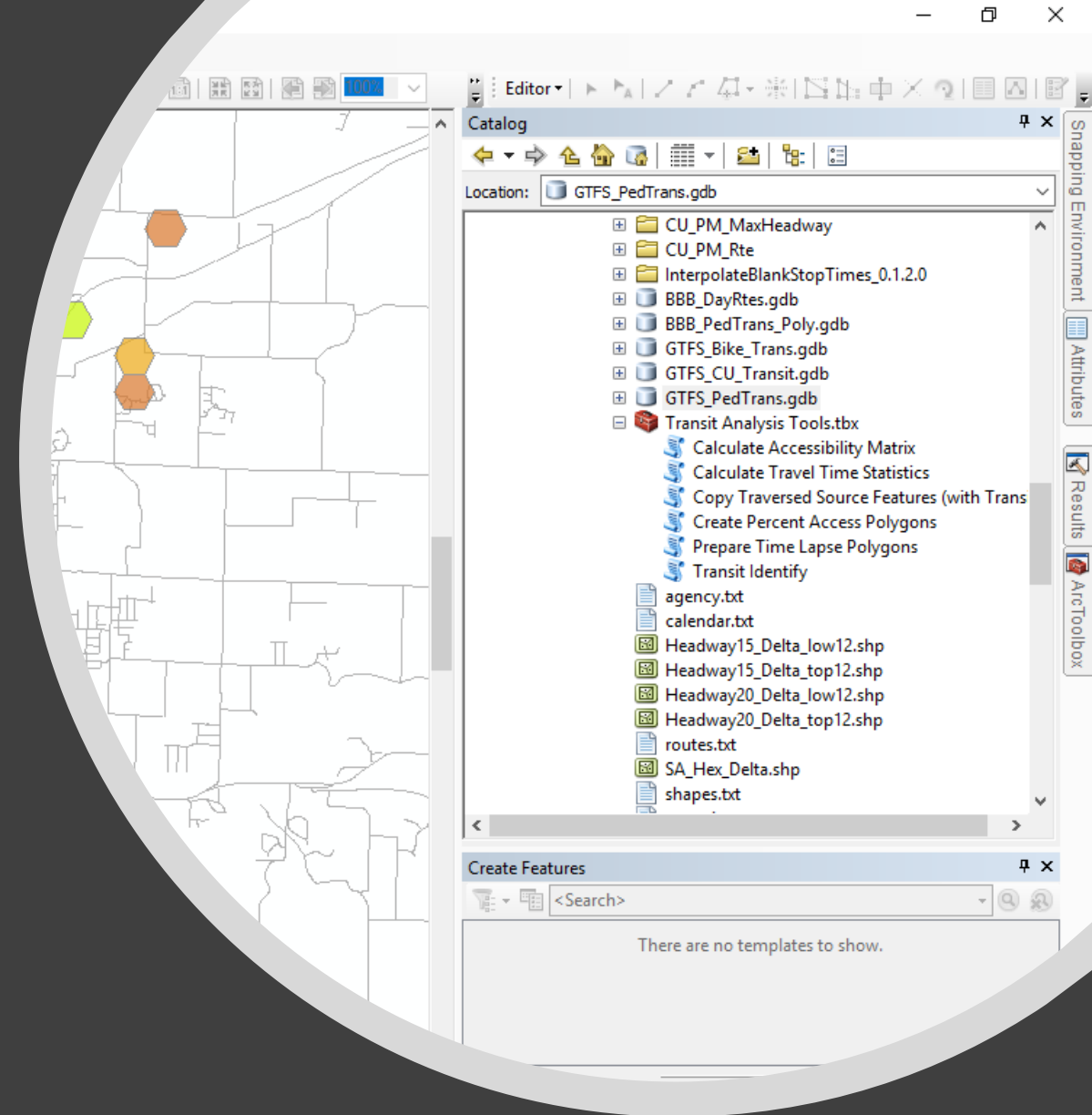
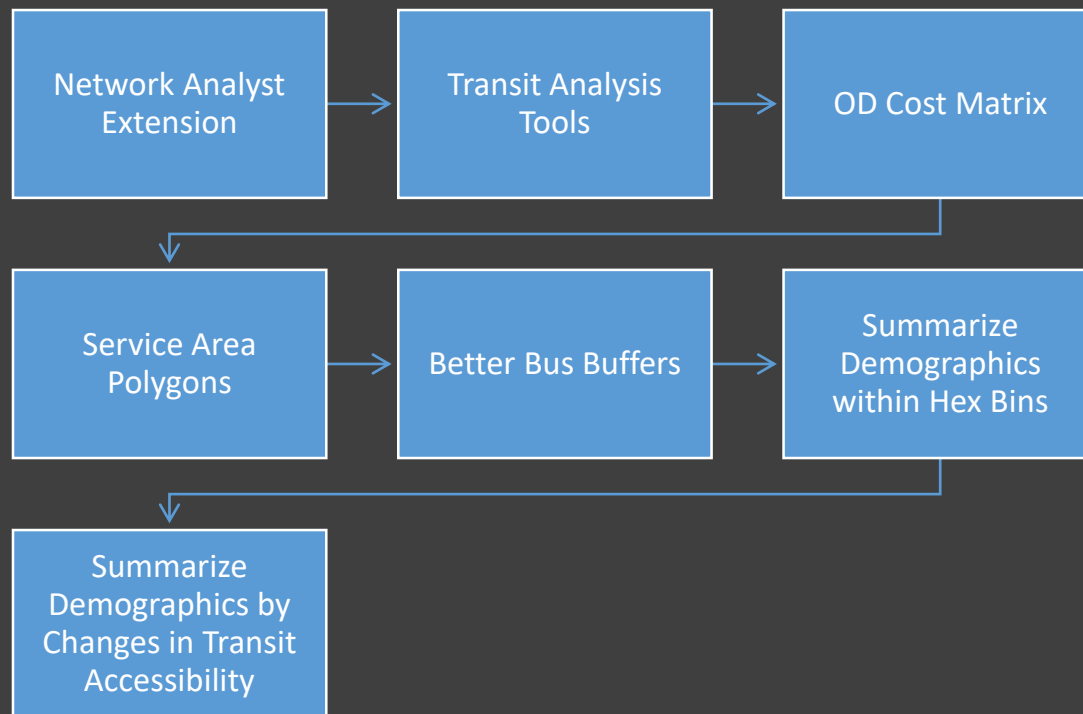
Create Features

<Search>

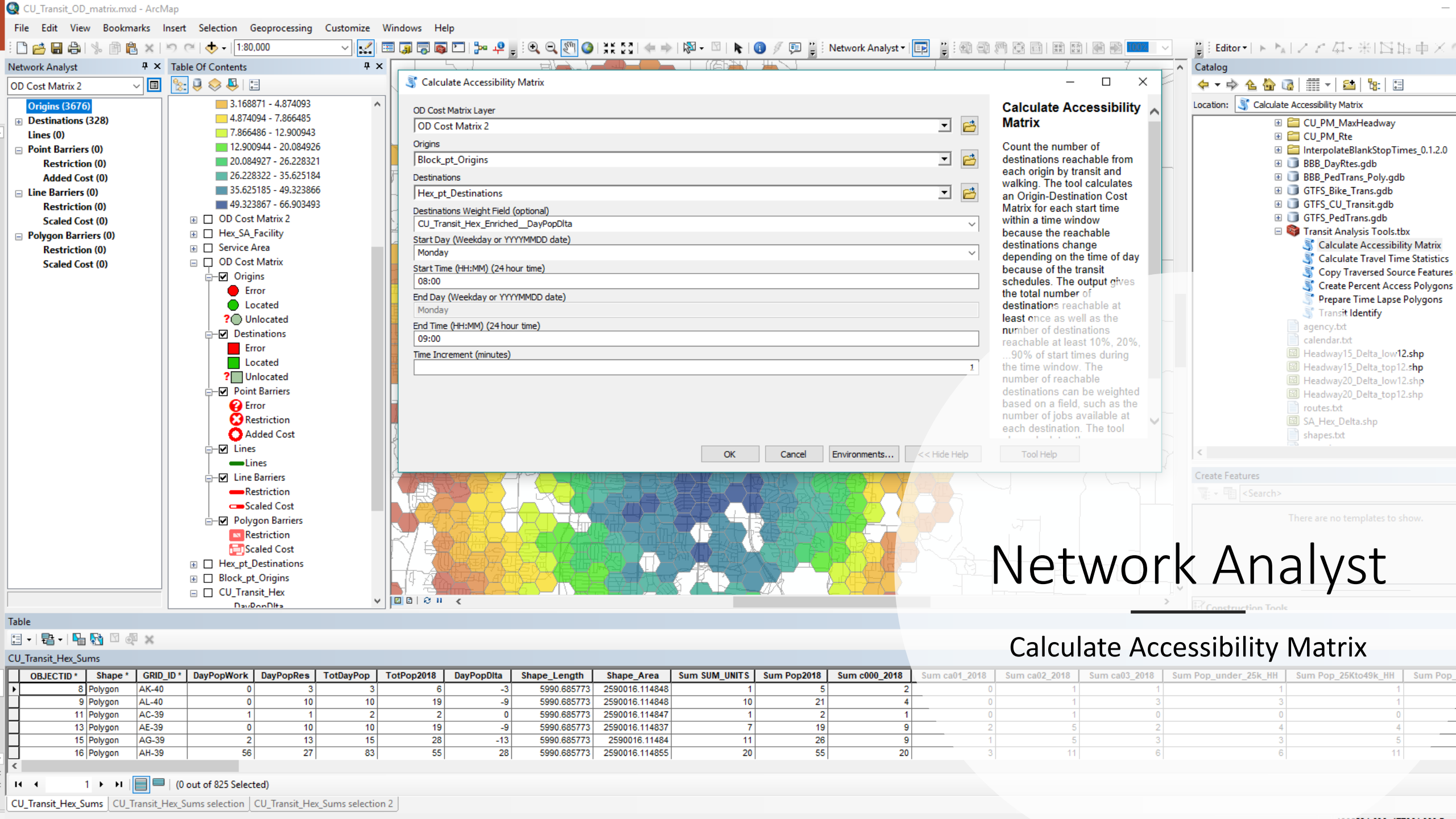
There are no templates to show.

Construction Tools

Choose Analysis Method and Tools



esri.github.io/public-transit-tools/TransitAnalysisTools.html



Calculate Transit Accessibility Matrix Output



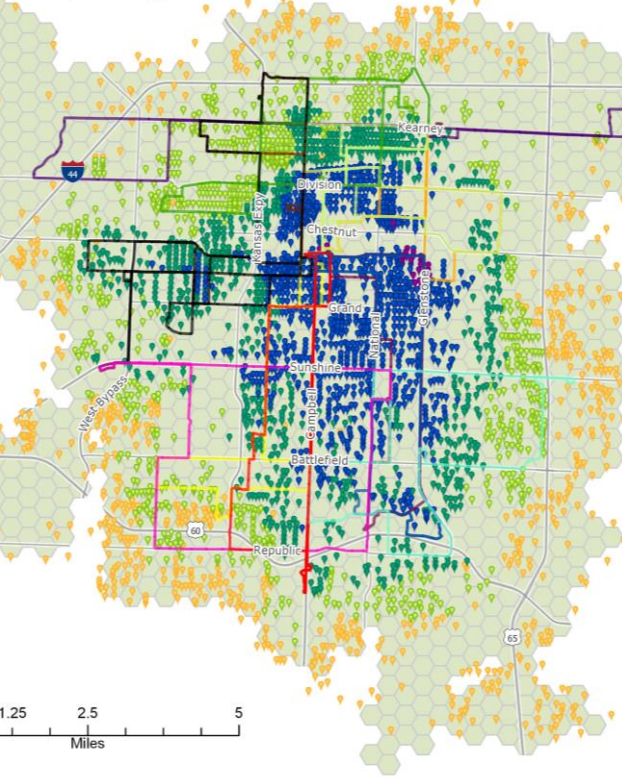
Percent of Reachable Activity Centers

- ≥ 85%
- 70% - 84.9%
- 50% - 69.9%
- 25% - 49.9%
- 0% - 24.9%

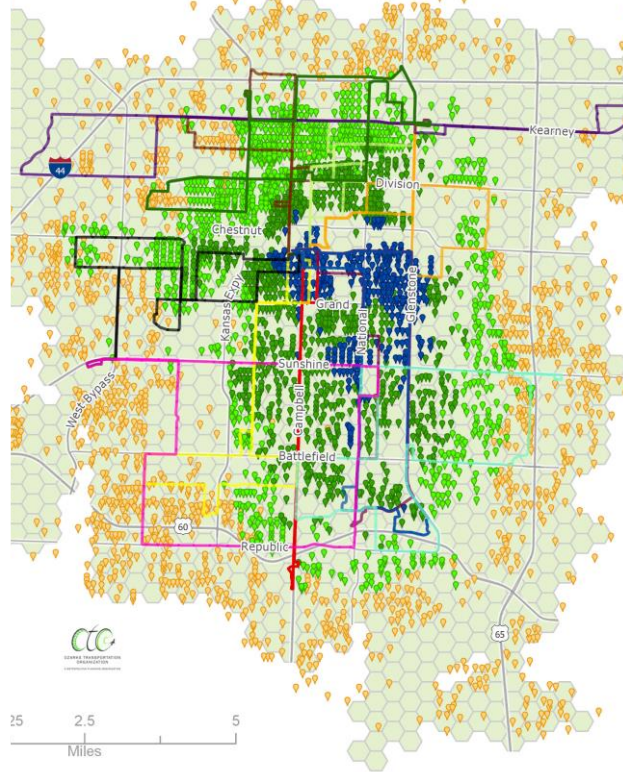
Bus Routes

- SW Loop Pink
- SE Loop Aqua
- North Loop Green
- Natl/Glenstone Maroon
- Industrial Express Purple
- Glenstone/National Blue
- Fort Yellow
- Division Orange
- Dale Lime
- College Black
- Campbell Red
- Atlantic Brown

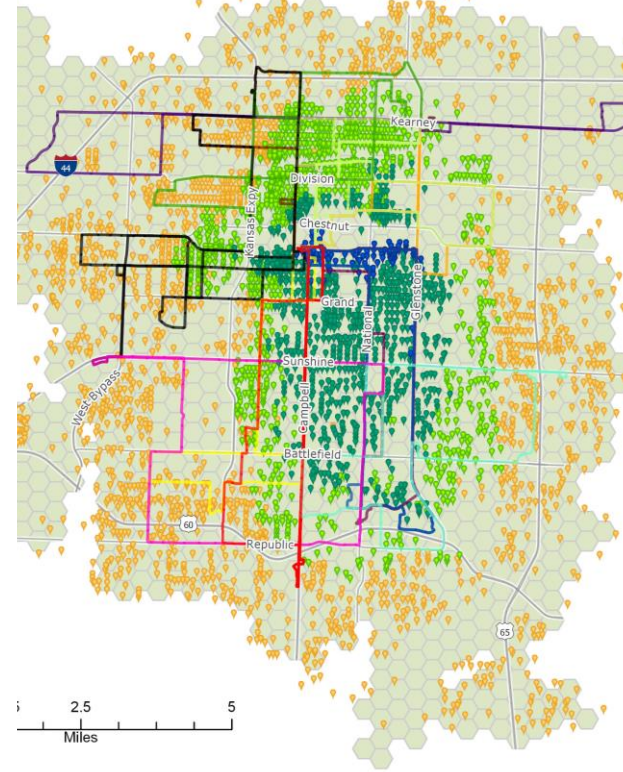
Percent* of Reachable Activities Weighted by 2018 Daytime
by Walking & Transit from Census Block Centroids for 20%



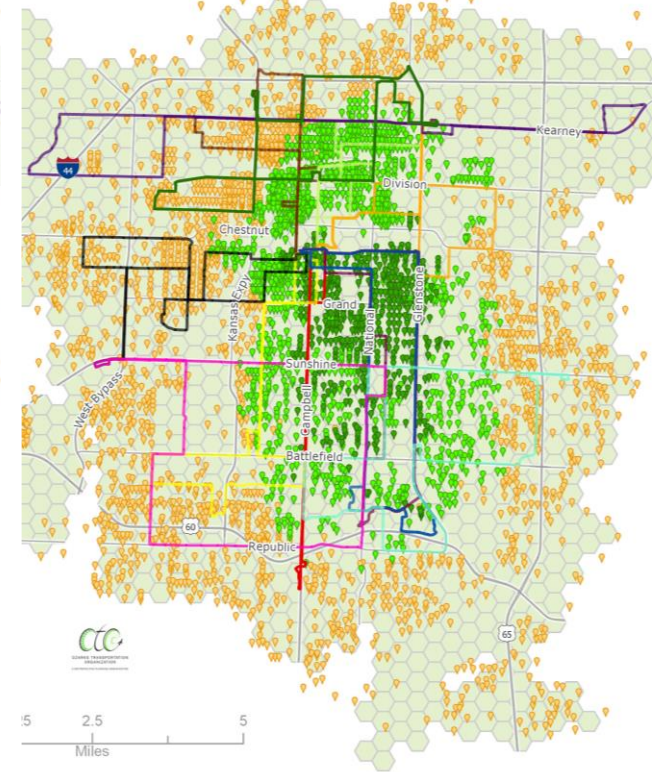
Percent* of Reachable Activities Weighted by 2018 Daytime
by Walking & Transit from Census Block Centroids for 50%



Percent* of Reachable Activities Weighted by 2018 Daytime
by Walking & Transit from Census Block Centroids for 70%

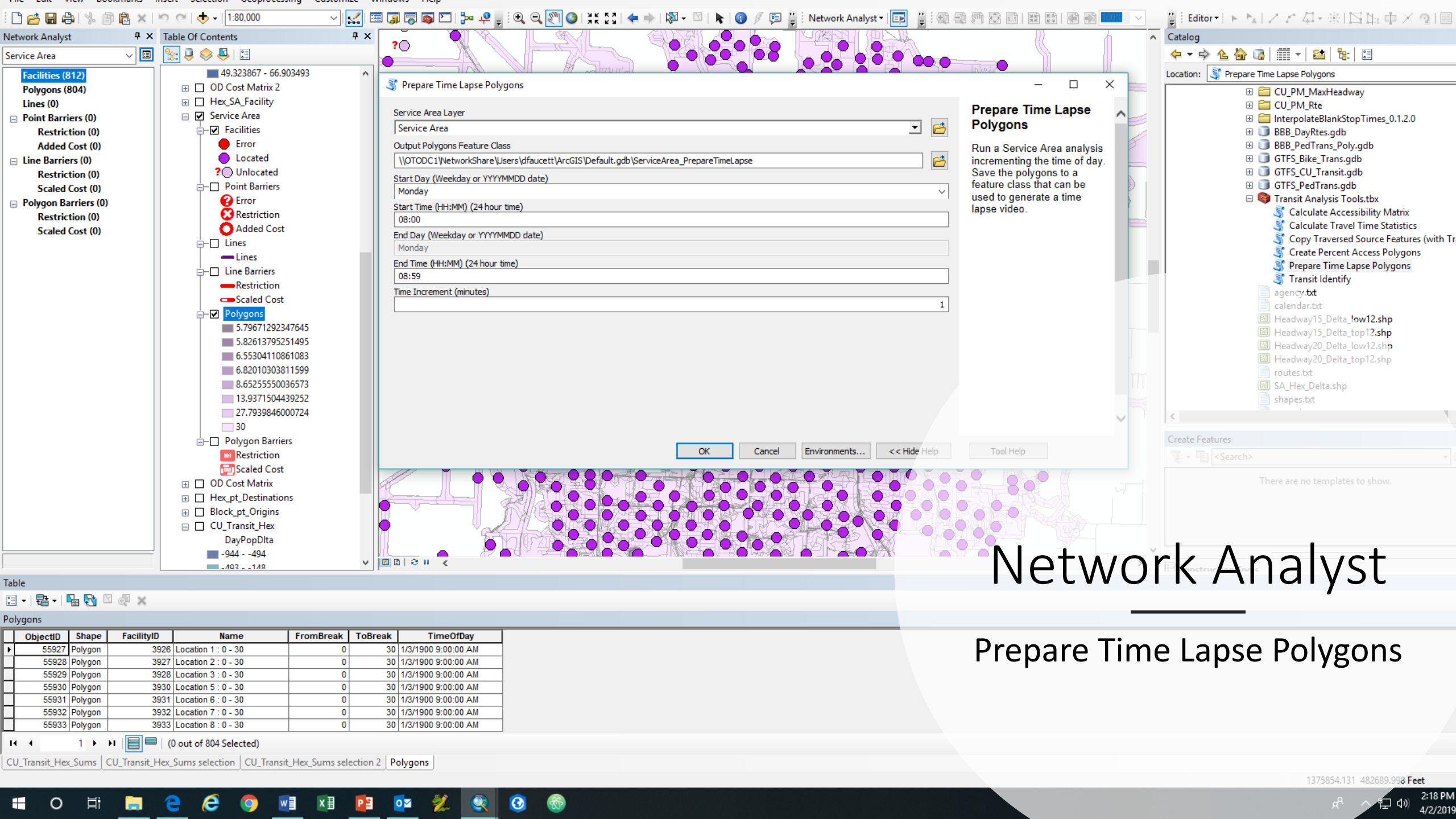


Percent* of Reachable Activities Weighted by 2018 Daytime
by Walking & Transit from Census Block Centroids for 90%



The % of opportunities reached decreases as the % of departure times increases

90% of departure times reflects the best measure



Prepare Time Lapse Polygons

Service Area Layer: Service Area

Output Polygons Feature Class: \\OTODC1\NetworkShare\Users\dfaucett\ArcGIS\Default.gdb\ServiceArea_PrepareTimeLapse

Start Day (Weekday or YYYYMMDD date): Monday

Start Time (HH:MM) (24 hour time): 08:00

End Day (Weekday or YYYYMMDD date): Monday

End Time (HH:MM) (24 hour time): 08:59

Time Increment (minutes): 1

Prepare Time Lapse Polygons

Run a Service Area analysis incrementing the time of day. Save the polygons to a feature class that can be used to generate a time lapse video.

OK Cancel Environments... << Hide Help Tool Help

Table

Polygons

ObjectID	Shape	FacilityID	Name	FromBreak	ToBreak	TimeOfDay
55927	Polygon	3926	Location 1 : 0 - 30	0	30	1/3/1900 9:00:00 AM
55928	Polygon	3927	Location 2 : 0 - 30	0	30	1/3/1900 9:00:00 AM
55929	Polygon	3928	Location 3 : 0 - 30	0	30	1/3/1900 9:00:00 AM
55930	Polygon	3930	Location 5 : 0 - 30	0	30	1/3/1900 9:00:00 AM
55931	Polygon	3931	Location 6 : 0 - 30	0	30	1/3/1900 9:00:00 AM
55932	Polygon	3932	Location 7 : 0 - 30	0	30	1/3/1900 9:00:00 AM
55933	Polygon	3933	Location 8 : 0 - 30	0	30	1/3/1900 9:00:00 AM

(0 out of 804 Selected)

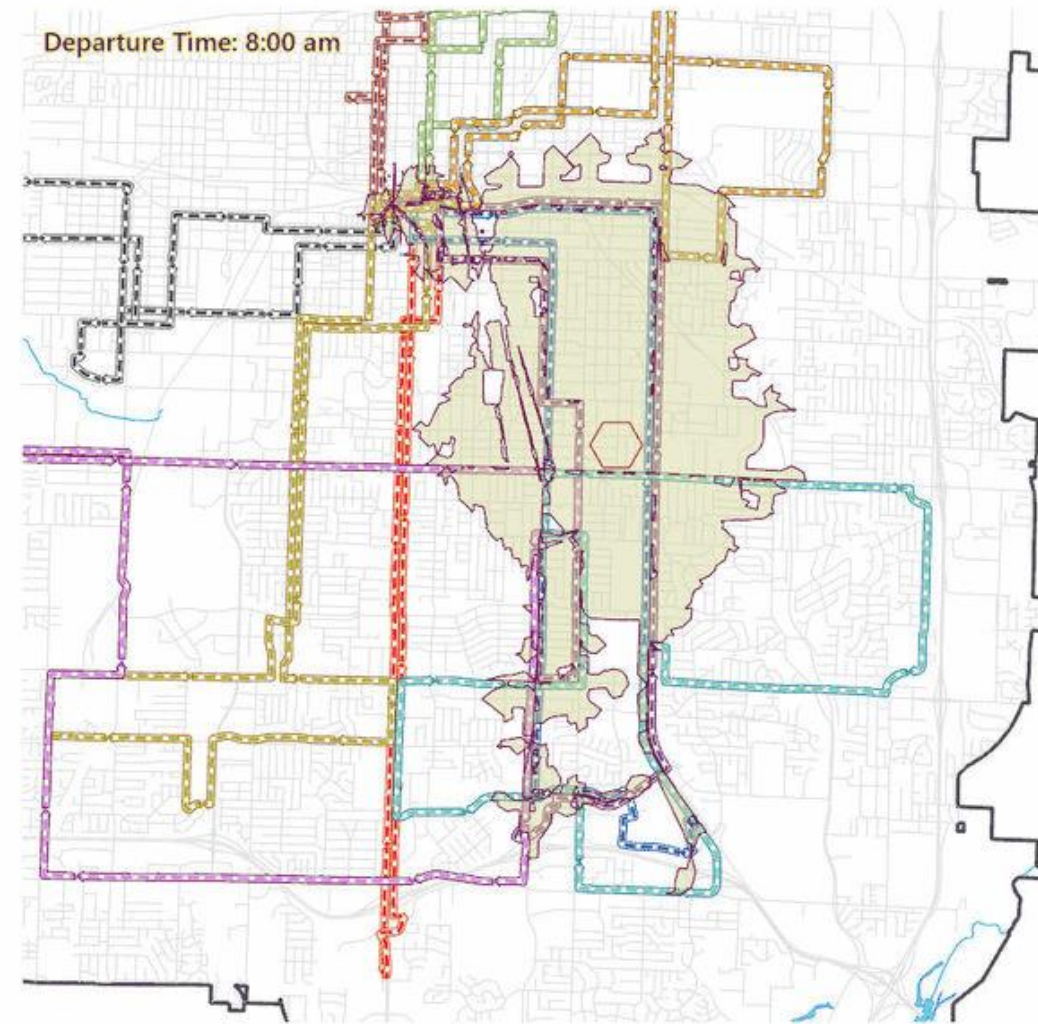
CU_Transit_Hex_Sums CU_Transit_Hex_Sums selection CU_Transit_Hex_Sums selection 2 Polygons

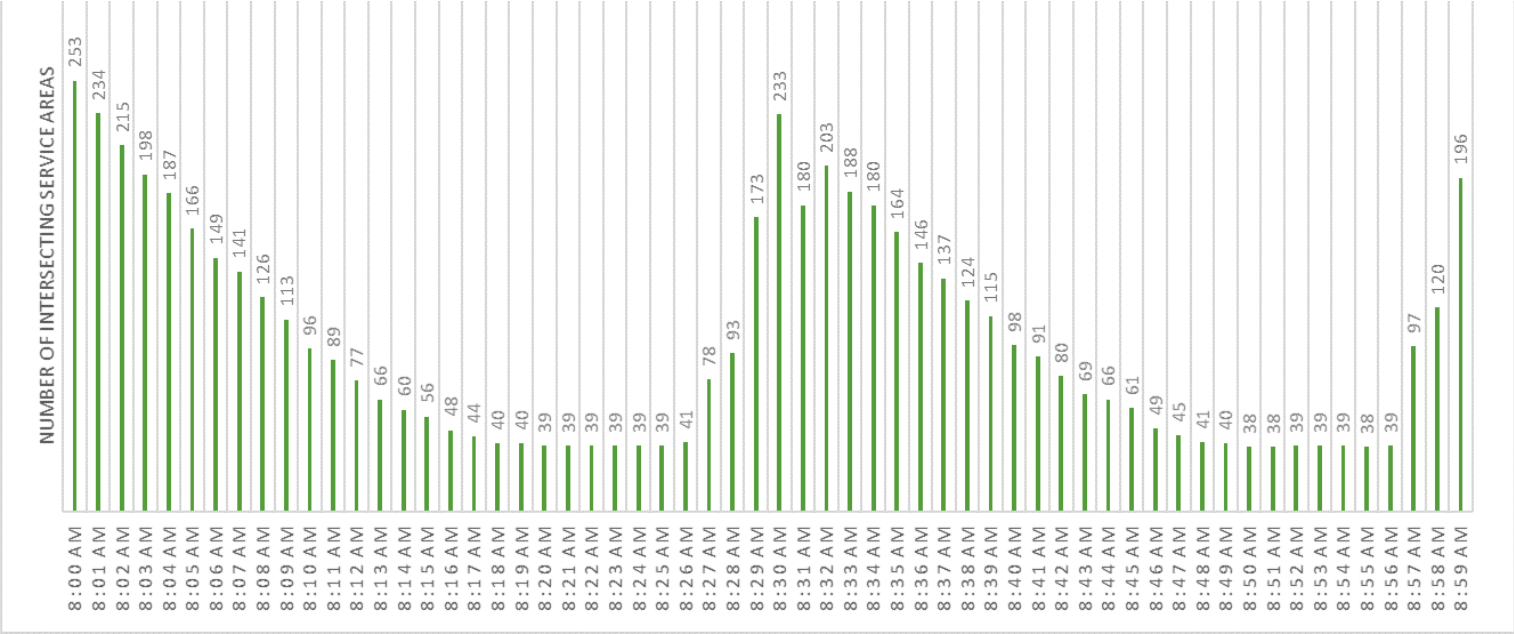
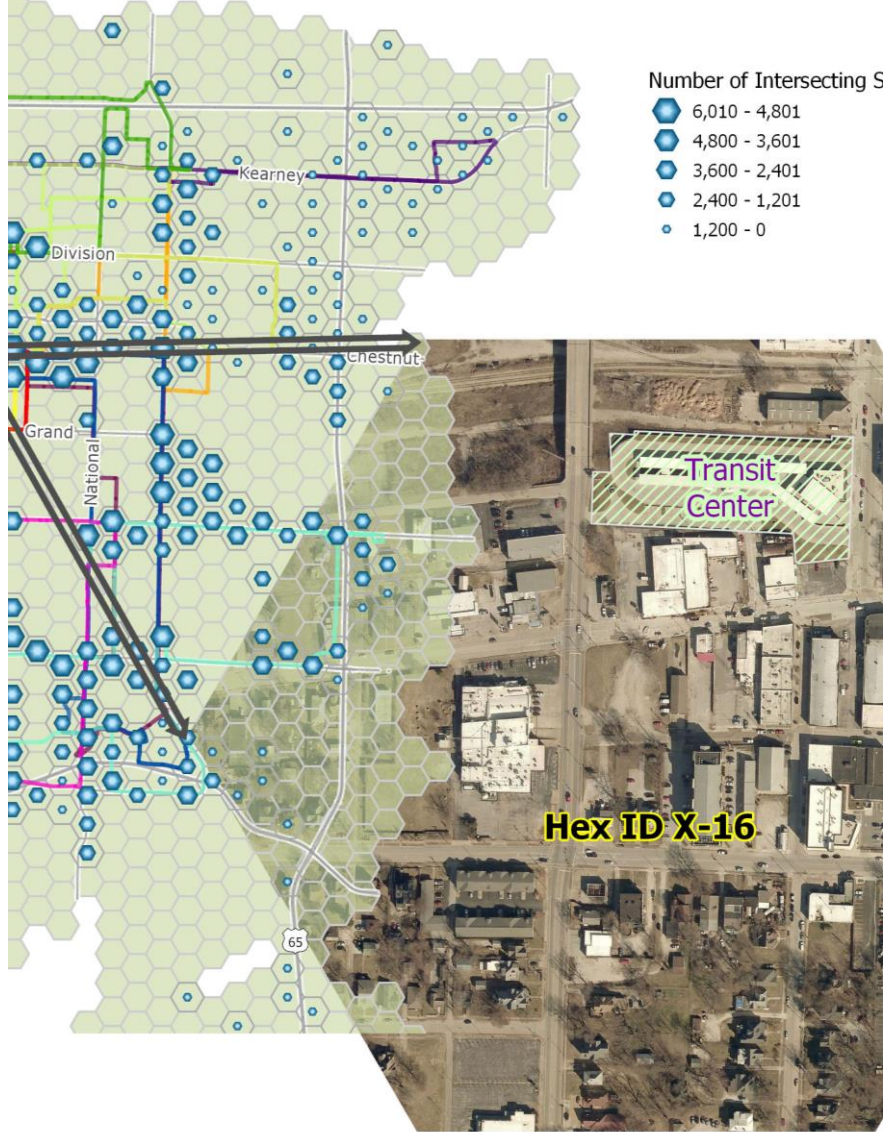
Network Analyst

Prepare Time Lapse Polygons

Create Time Lapse Polygons

- 30-minute Service Area Polygons
- Generate SA Polygons at one-minute intervals
- One-hour Time Window

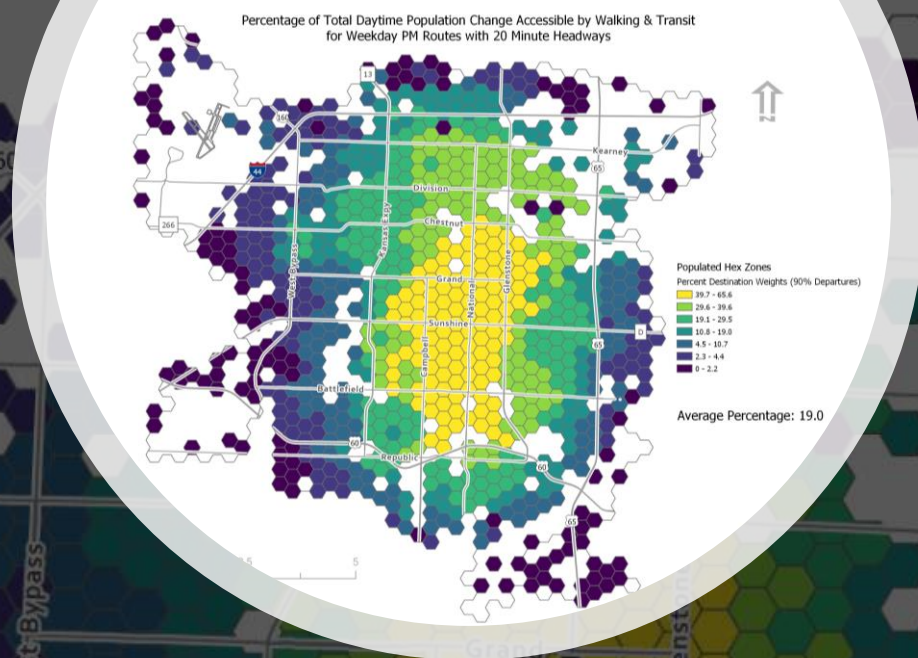


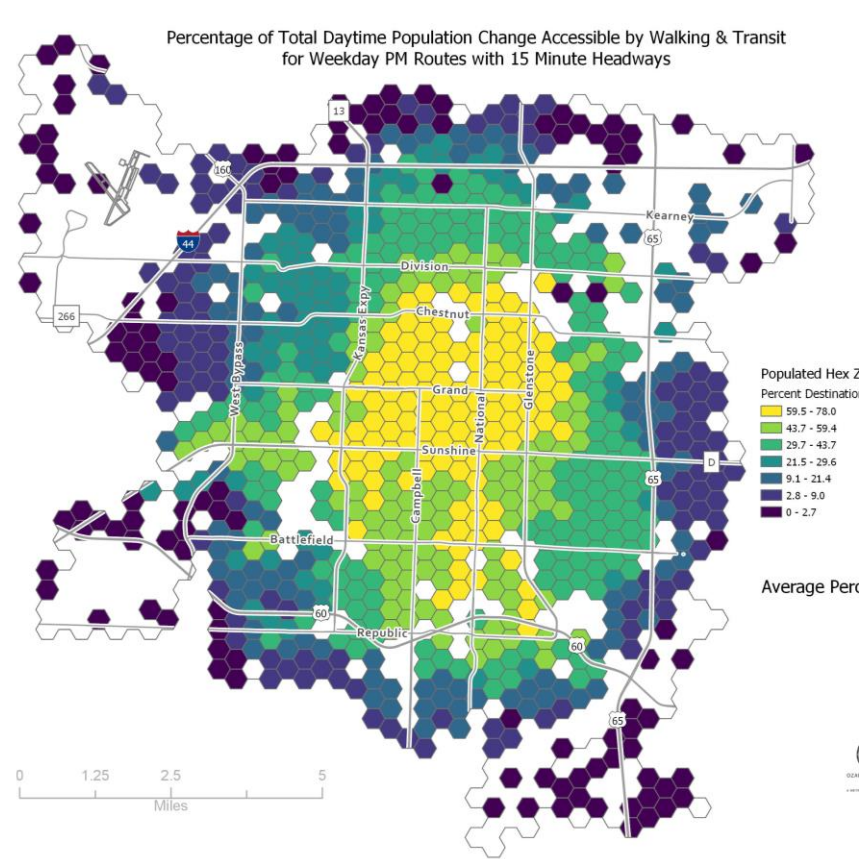
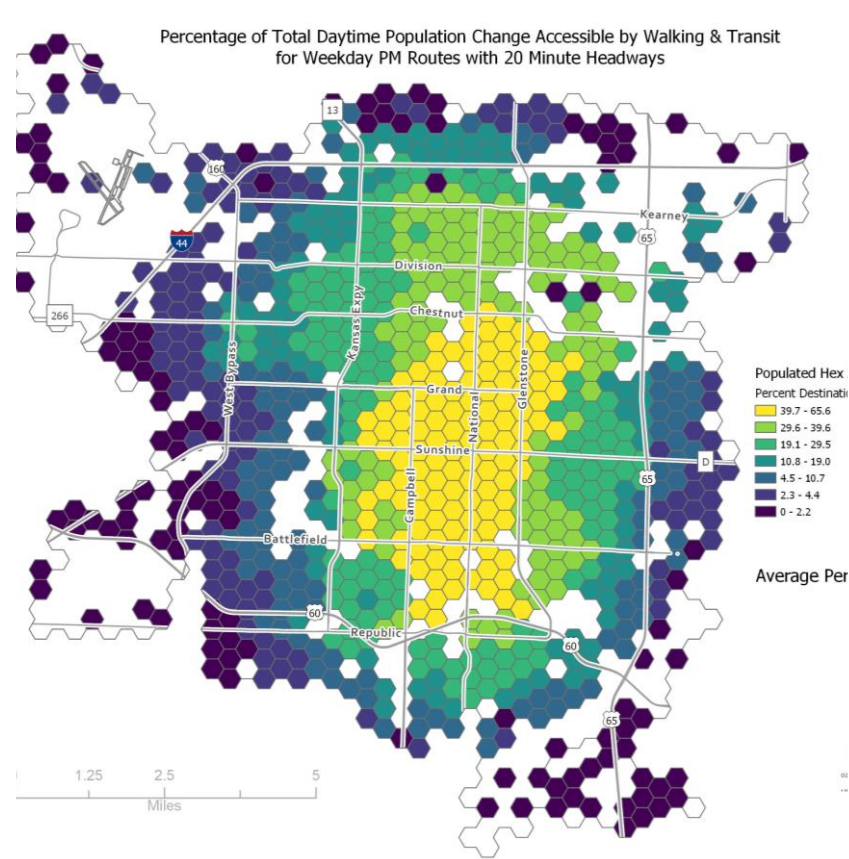
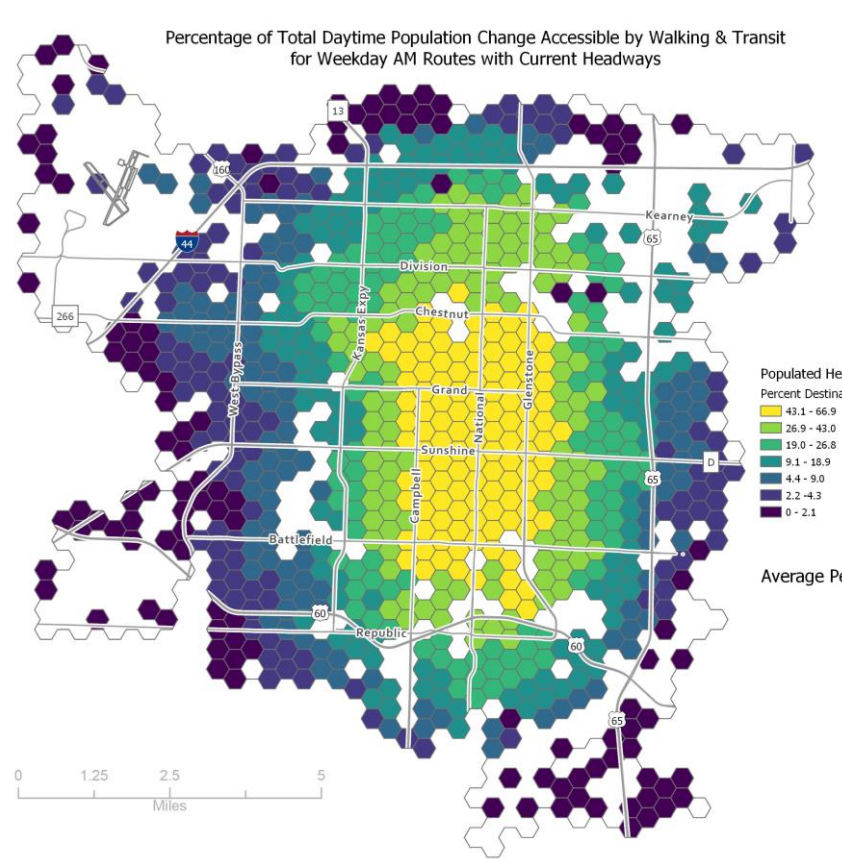


Activity Center Accessibility

The Hexagon with the most intersecting polygons was where the Transit Center is located

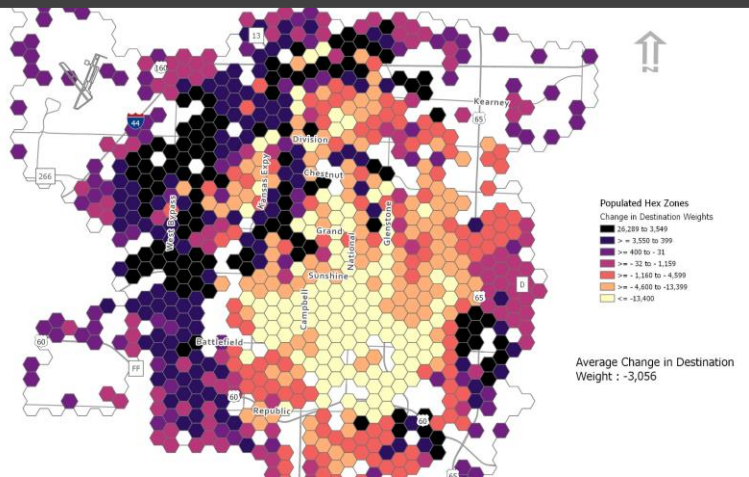
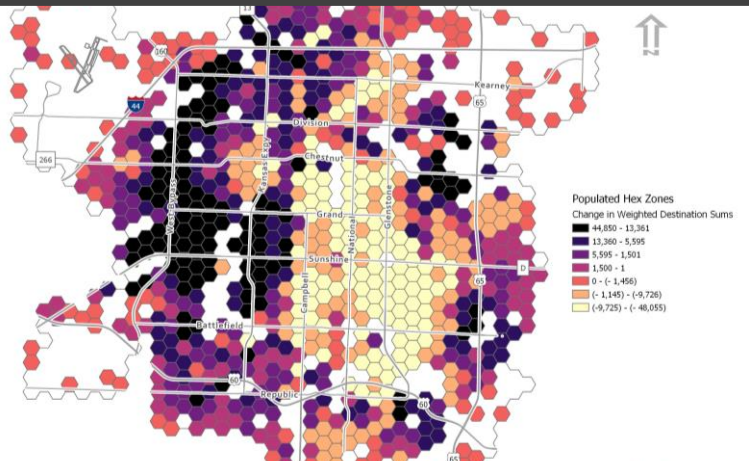
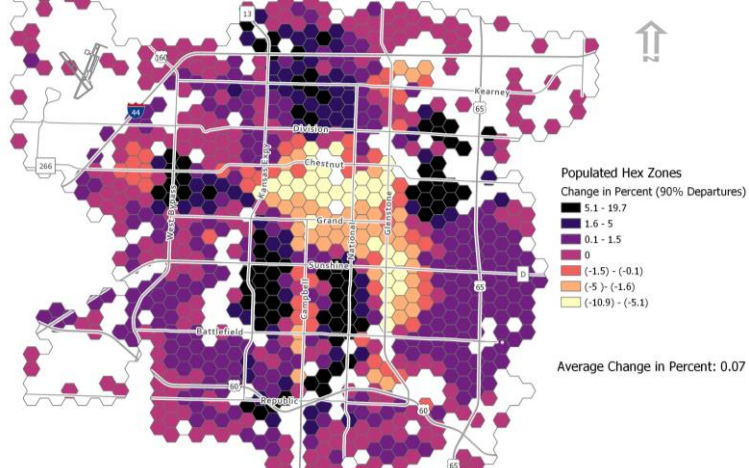
Perform the Analysis



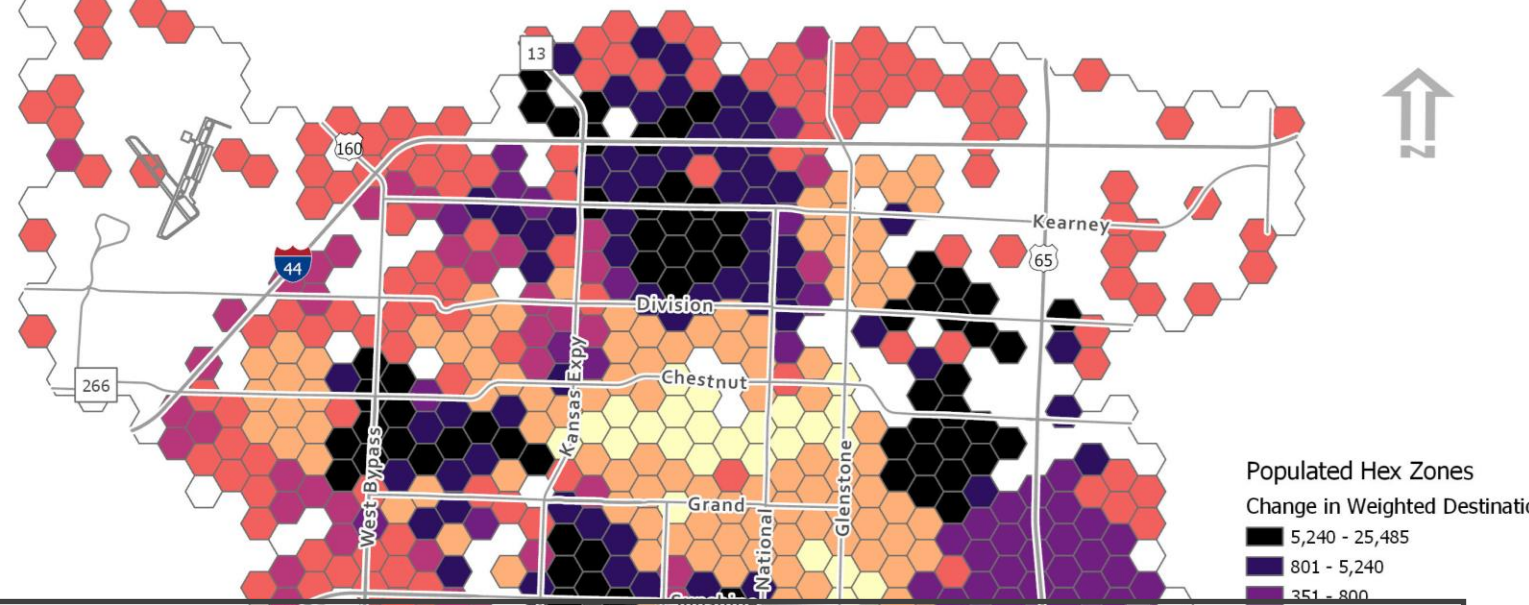


Edit GTFS Data for Scenarios

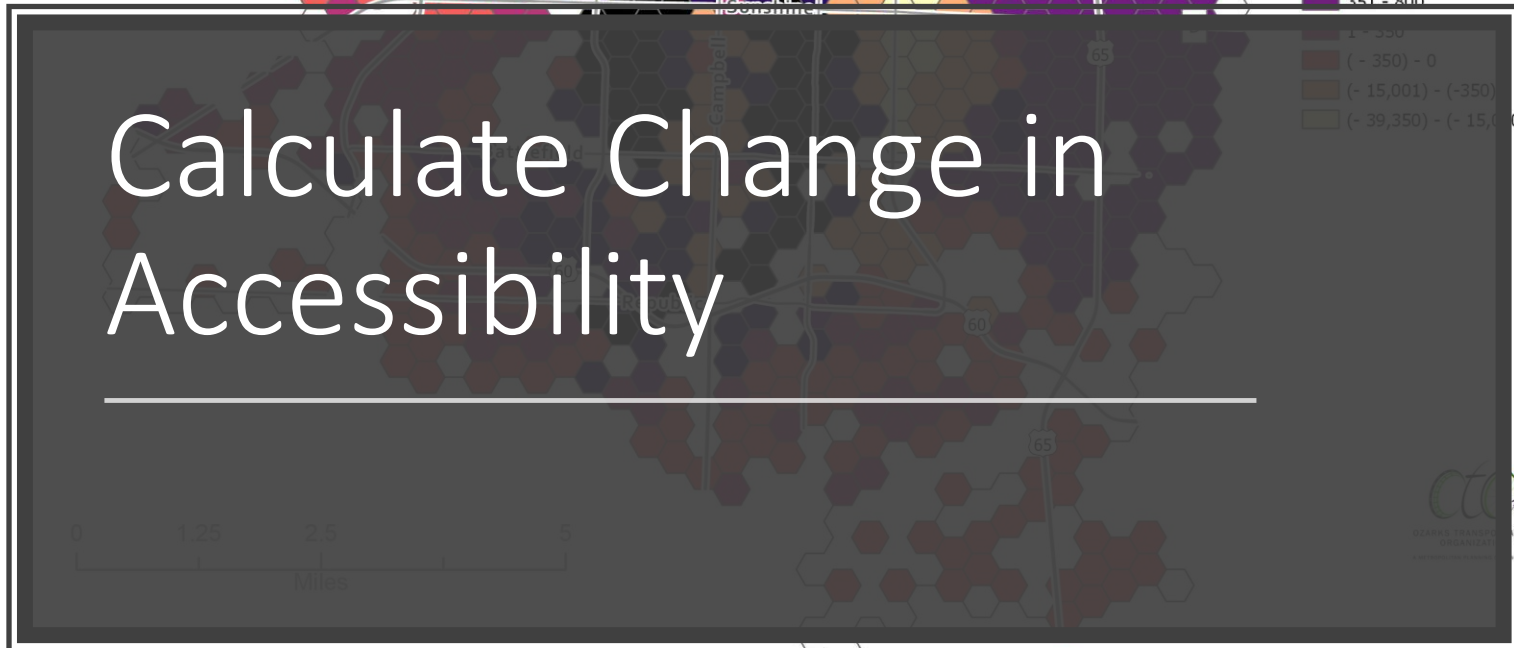
Calculate Accessibility Matrix for Route & Schedule Alternatives



Change in Weighted Destination Totals for Daytime Population Change on Day Routes with Current Headways vs. Night Routes with 20 Minute Headways



Calculate Change in Accessibility

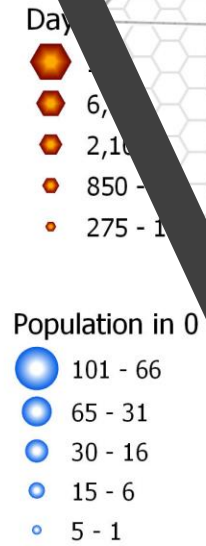


Population in Zero Car Households in Low income Areas with Below

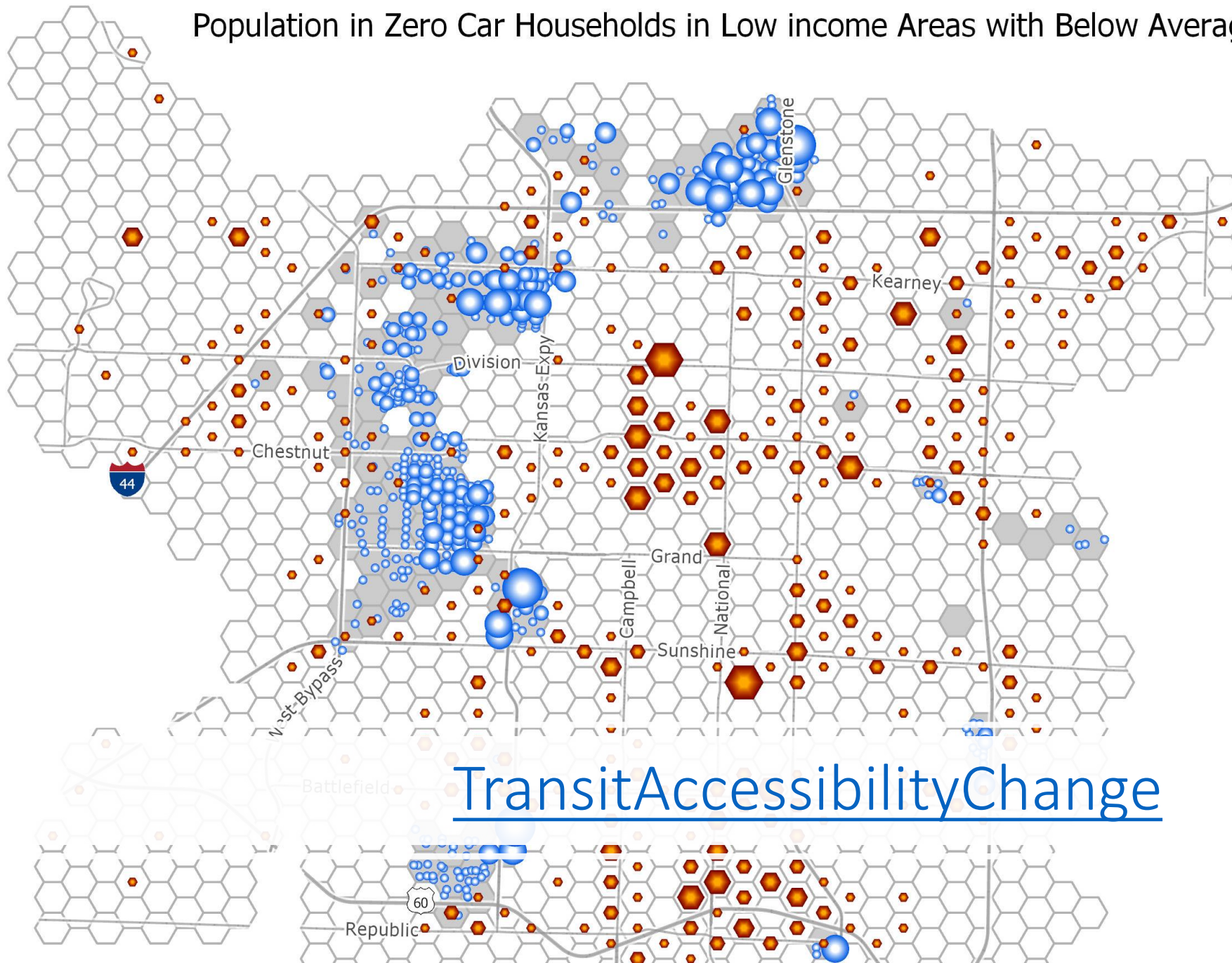
Examine and Refine
Results



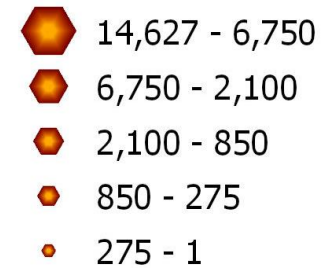
Low Transit Accessibility/Low Income Service Area Location
(20% of Destinations Reached during 90% of Departure Time)



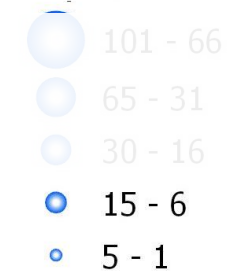
Population in Zero Car Households in Low income Areas with Below Average Transit Accessibility



Daytime Population Change



Population in 0 Vehicle Households

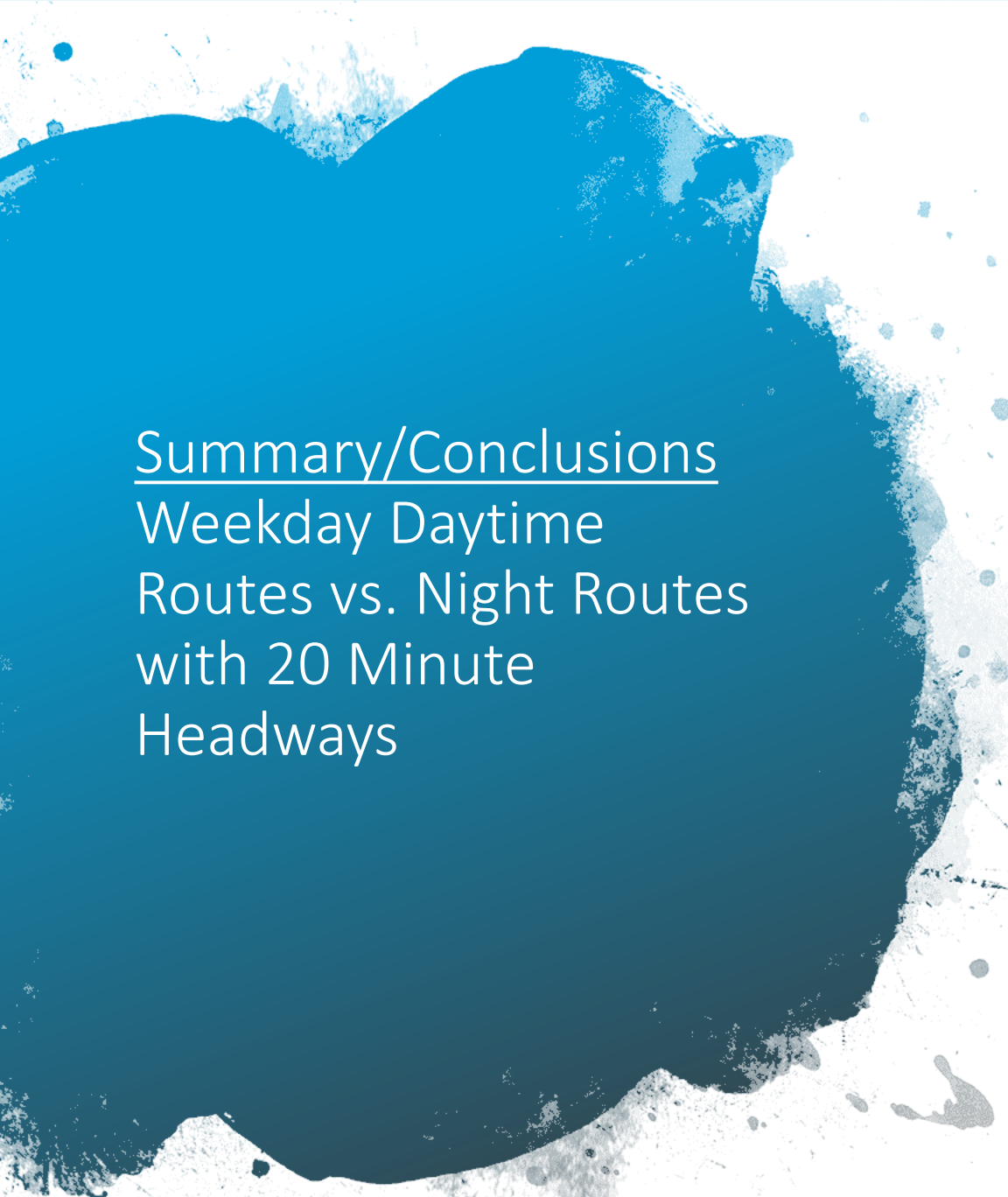


Estimated Population Characteristics for Areas with a Change in Cumulative Opportunities Greater than 5,000

2018 OTO Estimates	Number	%	2018 OTO Estimates	Number	%
Total Pop 2018	29,824	14.6	Left for Work 12pm to 3:59pm	1,110	9.0
Total Labor Force 2018	12,252	41.1	Left for Work 4pm to 11:59pm	1,201	9.8
Labor Force Age 29 or Younger	4,142	33.8	Left for Work 12am to 4:59am	432	3.5
Labor Force Age 30 to 54	5,315	43.3	Agriculture, Forestry, Mining Labor Force	51	0.4
Labor Force 55 to 69	2,795	22.8	Construction Labor Force	597	4.8
Pop living in less than \$25,000 Income Households	10,558	35.4	Manufacturing Labor Force	1,037	8.4
Pop living in \$25,000 to \$49,999 Income Households	10,550	35.3	Wholesale Trade Labor Force	379	3.1
Pop living in \$50,000 to \$74,999 Income Households	6,963	23.3	Retail Trade Labor Force	1,903	15.5
Pop living in \$75,000 and greater Income Households	1,778	6.0	Transportation & Warehousing Labor Force	632	5.1
Drove Alone to Work	10,146	82.8	Information Labor Force	212	1.7
Carpooled to Work	1,159	9.4	Finance & Insurance Labor Force	167	1.3
Public Transit to Work	54	0.4	Real Estate, Rental & Leasing Labor Force	167	1.3
Taxi to Work	68	0.5	Professional, Science, & Technology Labor Force	892	7.3
Motorcycle to Work	4	0	Management of Companies Labor Force	34	0.2
Bicycle to Work	163	1.3	Administrative Support & Waste Services Labor Force	849	6.9
Walk to Work	168	1.3	Education & Social Services Labor Force	951	7.7
Other Means to Work	98	0.7	Healthcare Labor Force	1,948	15.9
Worked at Home	379	3.1	Art & Entertainment Labor Force	159	1.3
Pop Living in 0 Vehicle Households	2,610	8.8	Accommodation & Food Service Labor Force	1,347	11.0
Pop Living in 1 Vehicle Households	13,802	46.2	Other Services Labor Force	532	4.3
Pop Living in 2 Vehicle Households	9,777	32.8	Public Administration Labor Force	405	3.7
Pop Living in 3 plus Vehicle Households	3,633	12.2	Less than 5 minutes to Work	460	3.8
Left for Work 5am to 5:29am	275	2.2	5 to 9 minutes to Work	1,597	13.0
Left for Work 5:30am to 5:59am	805	6.5	10 to 14 minutes to Work	2,687	22.0
Left for Work 6am to 6:29am	703	5.7	15 to 19 minutes to Work	3,122	25
Left for Work 6:30am to 6:59am	873	7.1	20 to 24 minutes to Work	2,167	17.6
Left for Work 7am to 7:29am	1,421	11.6	25 to 29 minutes to Work	674	5.5
Left for Work 7:30am to 7:59am	2,066	16.8	30 to 34 minutes to Work	804	6.5
Left for Work 8am to 8:29am	1,278	10.4	35 to 39 minutes to Work	60	0.4
Left for Work 8:30am to 8:59am	560	4.5	40 to 44 minutes to Work	78	0.6
Left for Work 9am to 9:59am	710	5.8	45 to 59 minutes to Work	268	2.2
Left for Work 10am to 10:59am	449	3.6	60 to 89 minutes to Work	124	1.0
Left for Work 11am to 11:59am	362	2.9	More than 90 minutes to Work	124	1.0

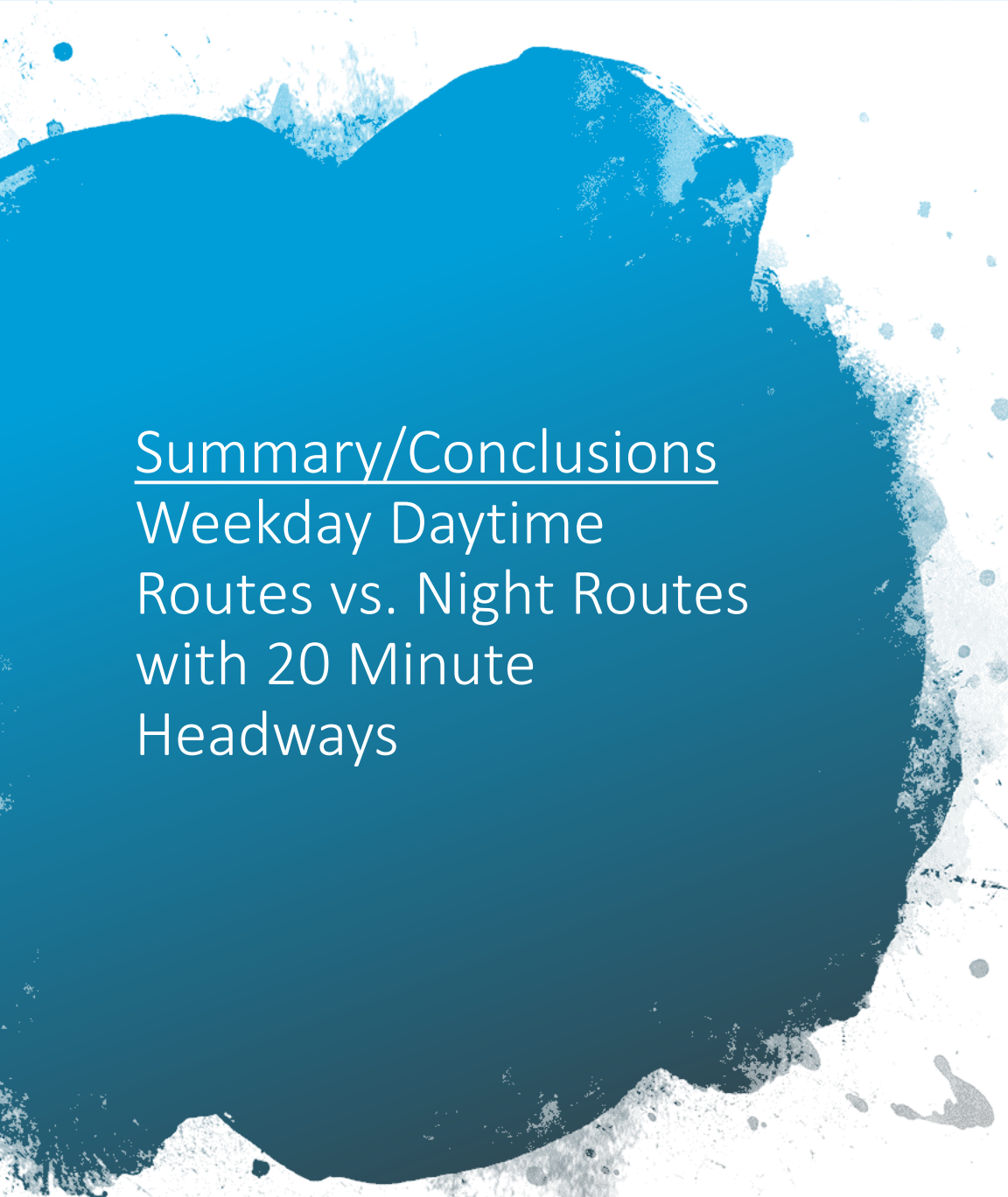
Estimated Population Characteristics for Areas with a Change in Cumulative Opportunities of -3,600 or Less

2018 OTO Estimates	Number	%	2018 OTO Estimates	Number	%
Total Pop 2018	37,513	18.4	Left for Work 12pm to 3:59pm	2,404	13.3
Total Labor Force 2018	18,052	48.1	Left for Work 4pm to 11:59pm	2,653	14.7
Labor Force Age 29 or Younger	9,221	51.1	Left for Work 12am to 4:59am	534	2.9
Labor Force Age 30 to 54	5,847	32.4	Agriculture, Forestry, Mining Labor Force	50	0.2
Labor Force 55 to 69	2,984	16.5	Construction Labor Force	940	5.2
Pop living in less than \$25,000 Income Households	17,566	46.8	Manufacturing Labor Force	915	5.0
Pop living in \$25,000 to \$49,999 Income Households	10,561	28.2	Wholesale Trade Labor Force	258	1.4
Pop living in \$50,000 to \$74,999 Income Households	7,108	18.9	Retail Trade Labor Force	2,838	15.7
Pop living in \$75,000 and greater Income Households	2,282	6.1	Transportation & Warehousing Labor Force	587	3.3
Drove Alone to Work	13,301	73.7	Information Labor Force	481	2.6
Carpooled to Work	1,634	4.4	Finance & Insurance Labor Force	394	2.2
Public Transit to Work	289	1.6	Real Estate, Rental & Leasing Labor Force	394	2.2
Taxi to Work	28	0.2	Professional, Science, & Technology Labor Force	1,226	6.8
Motorcycle to Work	89	0.5	Management of Companies Labor Force	21	0.01
Bicycle to Work	242	1.3	Administrative Support & Waste Services Labor Force	830	4.6
Walk to Work	1,633	9.0	Education & Social Services Labor Force	2,319	12.8
Other Means to Work	137	0.8	Healthcare Labor Force	2,451	14.0
Worked at Home	689	3.8	Art & Entertainment Labor Force	528	2.9
Pop Living in 0 Vehicle Households	4,830	12.9	Accommodation & Food Service Labor Force	2,580	14.3
Pop Living in 1 Vehicle Households	17,665	47.0	Other Services Labor Force	893	4.9
Pop Living in 2 Vehicle Households	10,972	29.2	Public Administration Labor Force	453	2.5
Pop Living in 3 plus Vehicle Households	4,050	10.8	Less than 5 minutes to Work	978	5.4
Left for Work 5am to 5:29am	276	1.5	5 to 9 minutes to Work	3,270	18.1
Left for Work 5:30am to 5:59am	428	2.3	10 to 14 minutes to Work	3,928	21.7
Left for Work 6am to 6:29am	931	5.2	15 to 19 minutes to Work	4,834	26.8
Left for Work 6:30am to 6:59am	1,210	6.7	20 to 24 minutes to Work	2,478	13.7
Left for Work 7am to 7:29am	1,655	9.2	25 to 29 minutes to Work	619	3.4
Left for Work 7:30am to 7:59am	2,564	14.2	30 to 34 minutes to Work	1,097	6.0
Left for Work 8am to 8:29am	1,908	10.5	35 to 39 minutes to Work	89	0.5
Left for Work 8:30am to 8:59am	733	4.0	40 to 44 minutes to Work	14	0.1
Left for Work 9am to 9:59am	1,323	7.3	45 to 59 minutes to Work	310	1.7
Left for Work 10am to 10:59am	1,066	5.9	60 to 89 minutes to Work	160	0.9
Left for Work 11am to 11:59am	366	2.0	More than 90 minutes to Work	160	0.9



Summary/Conclusions Weekday Daytime Routes vs. Night Routes with 20 Minute Headways

- Average Destinations Reached for 90% of Departures **18.9%** vs. **19%**
- Average Percent Change: **8.9%** Modest Areawide Improvement
- **Top 12%** change in cumulative opportunities sum: **5,000** or greater
 - 2018 population estimate: **29,824**
 - Percentages > than areawide %
 - Driving alone to work
 - Population in HHs with incomes less than \$49,999
 - Employment in Construction, Manufacturing, Retail, Food Service
 - Population Living in Zero and One vehicle HHs



Summary/Conclusions Weekday Daytime Routes vs. Night Routes with 20 Minute Headways

- Average Destinations Reached for 90% of Departures **18.9%** vs. **19%**
- Average Percent Change: **8.9%** Modest Areawide Improvement
- **Bottom 12%** change in cumulative opportunities sum: **-3,600** or less
 - 2018 population estimate: **37,513**
 - Percentages > than areawide %
 - Walking & transit to work
 - Population in HHs with incomes less than 25k
 - Workforce age 29 and younger
 - Employment in Construction, Retail, Education, & Food Service
 - Population Living in Zero and One vehicle HHs

Summary/Conclusions

Weekday Daytime Routes vs.
Night Routes with 15 Minute
Headways

- Average Destinations Reached for 90% of Departures **18.9%** vs. **29.6%**
- Average Percent Change: **60%** Dramatic Areawide Improvement
- **Top 12%** change in cumulative opportunities sum: **14,690** or greater
 - 2018 population estimate: **22,761**
 - Percentages > than areawide %
 - Workforce age 29 and younger
 - Population in HHs with incomes less than 50k
 - Drive alone to work and carpool
 - Employment in Manufacturing, Healthcare, & Food Service
 - Population Living in One vehicle HHs

Summary/Conclusions

Weekday Daytime Routes vs.
Night Routes with 15 Minute
Headways

- Average Destinations Reached for 90% of Departures **18.9%** vs. **29.6%**
- Average Percent Change: **60%** Dramatic Areawide Improvement
- **Bottom 12%** change in cumulative opportunities sum: **-11,850** or less
 - 2018 population estimate: **34,708**
 - Percentages > than areawide %
 - Workforce age 29 and younger
 - Population in HHs with incomes less than 25k
 - Walk to work and transit
 - Retail, Education, & Food Service
 - Population Living in Zero & One vehicle HHs
 - 14 minutes or less to work



OZARKS TRANSPORTATION ORGANIZATION

A METROPOLITAN PLANNING ORGANIZATION

Thank You!

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