THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

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DRT Accessibility Tool (P1)
User Guide (P2)
Workshop Materials (P3)

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THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

0-6768-P2

DRT Accessibility Tool: User Guide

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TxDOT Project 0-6768: Development of an Accessibility Formulation to Measure Customers' Evaluations of Demand Responsive Transit (DRT) Systems

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1. INTRODUCTION

This guide discusses a unique DRT Accessibility Tool developed for the Texas Department of Transportation. This tool addresses some of the challenges of operating a demand-responsive transit (DRT) system by determining how well a DRT system serves its riders as well as the most efficient ways to improve this service. The DRT Accessibility Tool is transferable, practical, and valuable for all small and medium-sized communities. The tool, which is formulated in Microsoft Access, uses a system of models to simulate actual daily DRT travel patterns for service regions and fleets of any size. Ultimately, DRT system operators can use the Accessibility Tool in two ways. First, they can evaluate their current accessibility levels for various combinations of population groups, times of day, and travel purposes. Second, the Accessibility Tool allows system operators to undertake "what if?" scenarios to evaluate changes in fleet characteristics (supply), population demographics (demand), and service areas (scope). These results have the potential to inform important public transportation planning, budgetary, and policy decisions.

While fleet size and efficiency are integral parts of DRT accessibility, ultimately the service must provide convenient connectivity between origins and destinations of interest to the patrons in order to be "accessible." As a result, accessibility is measured based on travel factors that are important to patrons, including travel time, drop-off delay, pickup time uncertainty, and unmet demand.

Using the Tool, system operators will be able to apply their knowledge of the service region, their patrons, and operations to arrive at solutions that are meaningful and specific to their area. However, system operators should keep in mind the particulars of a tool such as this that calculates accessibility for each zone relative to the other zones within the service region. This method allows system operators to identify those zones that stand out as having relatively high and low accessibility. With this updated version of the tool, system operators will be able to compare the accessibility indices of two different service regions because accessibility results are in terms of minutes of delay.

2. DRT ACCESSIBILITY TOOL INTRODUCTION

This section provides an overview of the DRT Accessibility Tool interface and the requirements for running the tool. Section 2.2 discusses processing requirements, including preferred system specifications and estimated run times. Section 2.3 thoroughly outlines the specific data required to run the tool, including what to include, how to structure it, and where to get it.

2.1 TOOL OVERVIEW

The DRT Accessibility Tool combines three modules into an attractive, intuitive, and user-friendly Microsoft Access database package, seen in Figure 1. Its user-friendly design is composed of three tabs based on the following specific modules: DRT Service Characteristics, DRT Travel Simulation, and DRT Accessibility Results. Users complete each tab in the order they are presented.

The tool has the option of running scenarios on different days, which will have the effect of changing the seed or scenario inputs. By holding the date constant in the upper right corner of the Microsoft Access main form, the same given characteristics will be held for all runs of the microsimulation. This approach allows accurate comparison of "what if?" scenarios, but also enables the user to change dates to see differences in accessibility due to randomization in the models.

Users first enter fleet and service area characteristics in the first tab shown in Figure 1. Users have the option of entering the data for each vehicle and service area zone in this tab or copying tables of data and pasting them directly into the corresponding tables. Note that users could check the "external zone" option to include main cities or other important destinations that are outside the service area but still attract trips.

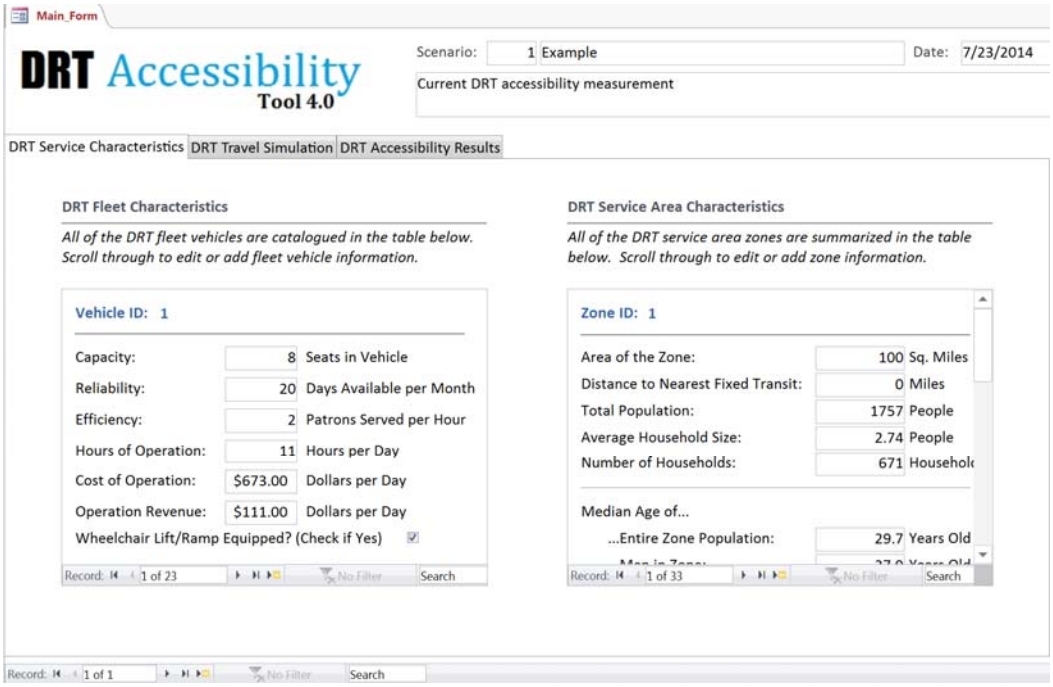


Figure 1: DRT Accessibility Tool: Service Characteristics Tab

Users then move to the second tab to run the travel simulation, shown in Figure 2. Simulations over longer time frames offer more precision simply because there are more iterations to compare. If a user will be calculating disaggregate accessibility measures, it is recommended that he/she increase the time frame.

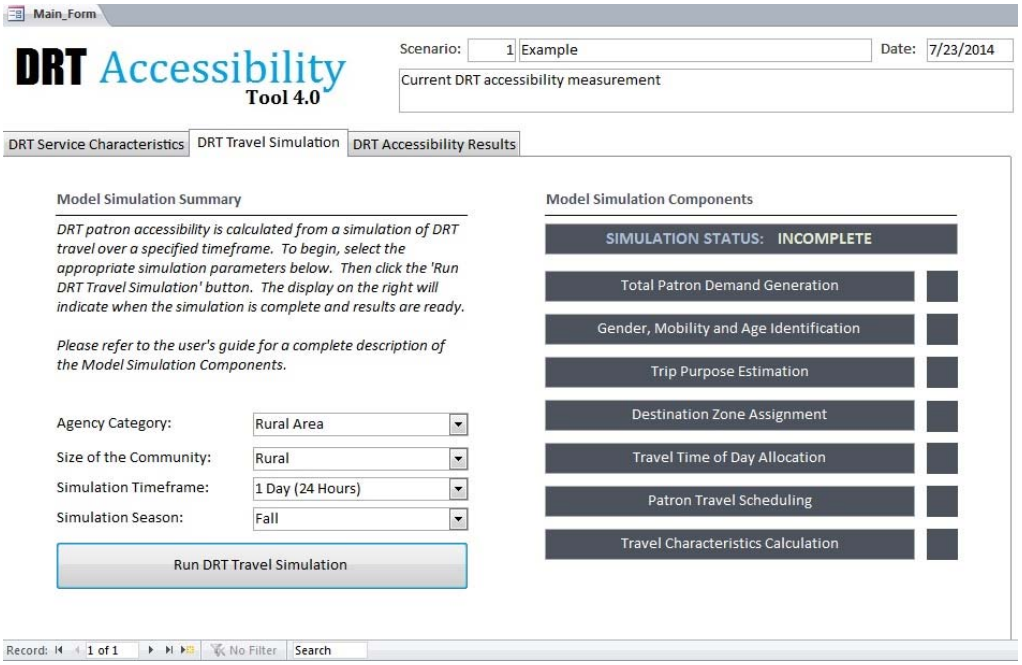


Figure 2: DRT Accessibility Tool: DRT Travel Simulation Tab

In the third tab, shown in Figure 3, users clearly define how they want to measure accessibility. Users have the option to use the predefined accessibility model parameters or to overwrite them. This feature allows users to use their own judgment in controlling these factors. The final results are queried based on the aggregation and presented in a pop-up table. This tab also features a list of economic details—such as operating costs, generated revenue, and total number of patrons served—that can be compared with the accessibility measure results.

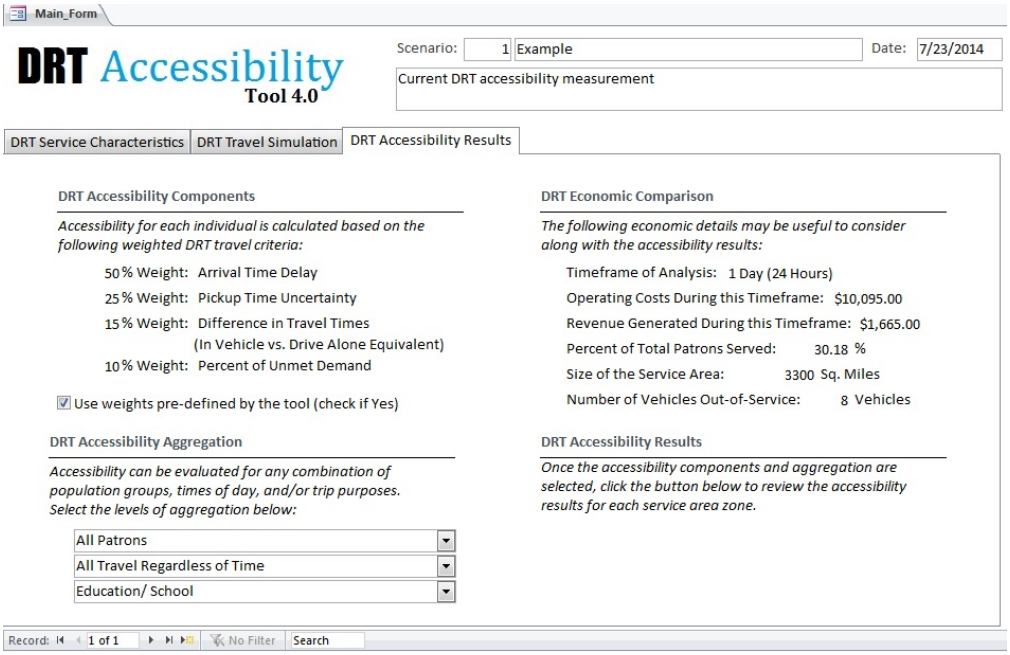


Figure 3: DRT Accessibility Tool: DRT Accessibility Results Tab

2.2 PROCESSING REQUIREMENTS

2.2.1 Preferred System Specification

The minimum computer specifications required to run the DRT Accessibility Tool are a two-GHz Processor and two GB of RAM. Also, because the DRT Accessibility Tool is a database application that relies on functions found within Microsoft Access 2007, users will need to have the most recent version of Microsoft Office to open and run the tool. It is recommended that users are also familiar with Microsoft Access 2007 (or later versions), as this will aid in entering the data.

2.2.2 Estimated Run Times and Factors

The time it takes to run the DRT Accessibility Tool directly depends on the size of the service area used in the scenario. As a result, scenarios with larger service areas will take longer than scenarios with smaller service areas. However, running times are not excessive. For example, a typical service area within rural community or town of roughly 100 square miles will take about 15 minutes to run.

It is also important to recognize that the tool calculates DRT accessibility based on a number of estimated factors, including patron demographics and travel characteristics. Users have the option of improving the precision of these DRT accessibility measures by increasing the time frame of the study from 1 day (24 hours) to 3 days (72 hours) or 1 week (7 days), but at the cost of increasing the run time. If the user selects either “3

Days" or "1 Week," the tool will increase the number of iterations and running time by magnitudes of three and seven times, respectively. The accessibility values are then averaged out over these time frames.

Once the tool has run, however, the results are permanently saved. This feature ensures that users do not need to run the simulation every time they want to review accessibility measures. Users can run the simulation, close the tool, and come back later to review the results.

2.3 DATA REQUIREMENTS

The DRT Accessibility Tool requires three tables of information in order to simulate and measure DRT accessibility. These tables include a Service Area Characteristics Table, a Fleet Characteristics Table, and a Zone Distances Table. The contents of these tables and possible data sources are outlined in the following sections.

2.3.1 Service Area Characteristics Table

It is recommended that users first compile and generate the service area characteristics in ArcGIS. ArcGIS is especially helpful in calculating certain characteristics, such as "Distance from Zone Centroid to Nearest Transit Line," and the ArcGIS zone database can be easily exported and edited. It is also recommended that users build the Service Area Characteristics Table in Microsoft Excel for ease in copying the data into the tool. It is also useful to have an ArcGIS map of the service area zones to incorporate and present the final accessibility measures.

The Service Area Characteristics Table should be set up so that each zone is a row, or record, and characteristics are listed as columns. The characteristics required for each zone, which can be treated as the column headings, are as follows:

- Scenario ID [1]
- Zone ID [2]
- Total Number of Households Living within the Zone
- Total Number of People Living within the Zone [3]
- Area of Zone, in Square Miles
- Population Density of Zone, in Number of People/Square Mile[4]
- Distance from Zone Centroid to Nearest Transit Line [5]
- Median Age of Total Zone Population
- Median Age of Men within the Zone
- Median Age of Women within the Zone

- Average Household Size within the Zone
- Total Number of Households that Rent within the Zone
- Total Number of Households that Are Married with Children within the Zone
- Total Number of Households that Are Married without Children within the Zone
- Total Number of People Living in Zone Aged 18 or Younger
- Total Number of People Living in Zone Aged 18–65
- Total Number of People Living in Zone Aged 65 or Older
- Percent of Area within the Zone Designated for Agricultural [6]
- Percent of Area within the Zone Designated for Commercial (including Public Buildings and Space) [6]
- Percent of Area within the Zone Designated for Industrial [6]
- Percent of Area within the Zone Designated for Residential [6]
- Number of Patrons [7]

ADDITIONAL COMMENTS:

1. The *Scenario ID* is one greater than the number of scenarios already saved in the tool. Every record (i.e., zone) within a given scenario MUST have the same *Scenario ID* in all three tables.
2. Users may use any numbering system to identify the zones, but this numbering system MUST be consistent with the Zone Distances Table. The numbering system MUST have unique IDs for each zone.
3. The tool will give an error if this column has any zeroes, so place a 1 in any zones with no population. This will also affect the *Population Density of Zone*, below.
4. *Population Density of Zone* = *Total Number of People Living within the Zone/Area of Zone*
5. *Distance from Zone Centroid to Nearest Transit Line* can be calculated in ArcGIS using the following general steps. If you do not have this information, just enter all zeroes in this column.
    a. Convert zones into centroids.
    b. Join centroids with the transit route layer. Record distance value.
    c. Join centroids back to zones.
6. The sum of these five land use designations must be less than or equal to 100% for each zone.
7. This column must be all blank. The number of patrons is calculated by the tool, but this column MUST be blank to start with.

The DRT Accessibility Tool was designed using census block groups as the service area zone system. As such, the model and table are designed around the census block group summary file 1 demographic data.

2.3.2 Fleet Characteristics Table

The second data table describes the DRT fleet, which can be composed of any number of different paratransit vehicles. It is recommended that users build the Fleet Characteristics Table in Microsoft Excel for ease in copying the data into the tool.

The Fleet Characteristics Table should be set up so that each vehicle is a row, or record, and characteristics are listed as columns. The characteristics required for each vehicle, which can be treated as the column headings, are as follows:

- Scenario ID [1]
- Vehicle ID [2]
- Capacity, described as the maximum number of passengers the vehicle can hold
- Reliability, described as the number of days the vehicle is available in an average month
- Efficiency, described as the number of patrons the vehicle can typically serve in an hour
- Daily Cost of Vehicle Operation, in Dollars
- Daily Revenue of Vehicle Operation, in Dollars
- Number of Hours Vehicle Is in Service Each Day
- Vehicle Ability to Support Mobility-Impaired Patrons (designated as TRUE or FALSE)

ADDITIONAL COMMENTS:

1. The *Scenario ID* is one greater than the number of scenarios already saved in the tool. Every record (i.e., vehicle) within a given scenario MUST have the same *Scenario ID* in all three tables.
2. Users may use any numbering system to identify the vehicles, but this numbering system MUST have unique IDs for each vehicle.

2.3.3 Zone Distances Table

The final data table lists the straight line distance between the centroids of every possible pair of service area zones. This table is important to create spatial relationships between each of the zones. It is recommended that users first build the table in Microsoft Excel for ease in copying the data into the tool.

The Zone Distances Table should be set up so that there is one row, or record, for every pair of zones. It is important to note that order matters in this table because zones are being treated as "Origins" and "Destinations," so the table needs to include reverse combinations as well. The column headings in this table are as follows:

- Scenario ID [1]
- Origin Census Block Group ID [2]
- Destination Census Block Group ID [2]
- Distance between Origin and Destination Census Block Groups, in Miles

ADDITIONAL COMMENTS:

1. The *Scenario ID* is one greater than the number of scenarios already saved in the tool. Every record (i.e., zone pair) within a given scenario MUST have the same *Scenario ID* in all three tables.
2. Users MUST use the zone numbering system introduced in the Service Area Characteristics Table.

3. USING THE TOOL STEP-BY-STEP

The purpose of this section is to provide step-by-step instructions for (1) opening the tool, (2) entering data, (3) measuring accessibility, and (4) presenting results in ArcGIS.

3.1 OPENING THE TOOL

STEP 1: Open DVD

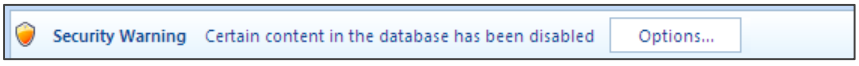
1. Put DVD into computer, and open window to display contents.
2. Right-click file entitled "DRT Accessibility Tool.accdb."
3. Select "Copy."

STEP 2: Copy DVD Contents

1. Navigate to and open the folder where you would like to store the tool file.
2. Right-click any blank space in the folder.
3. Select "Paste."

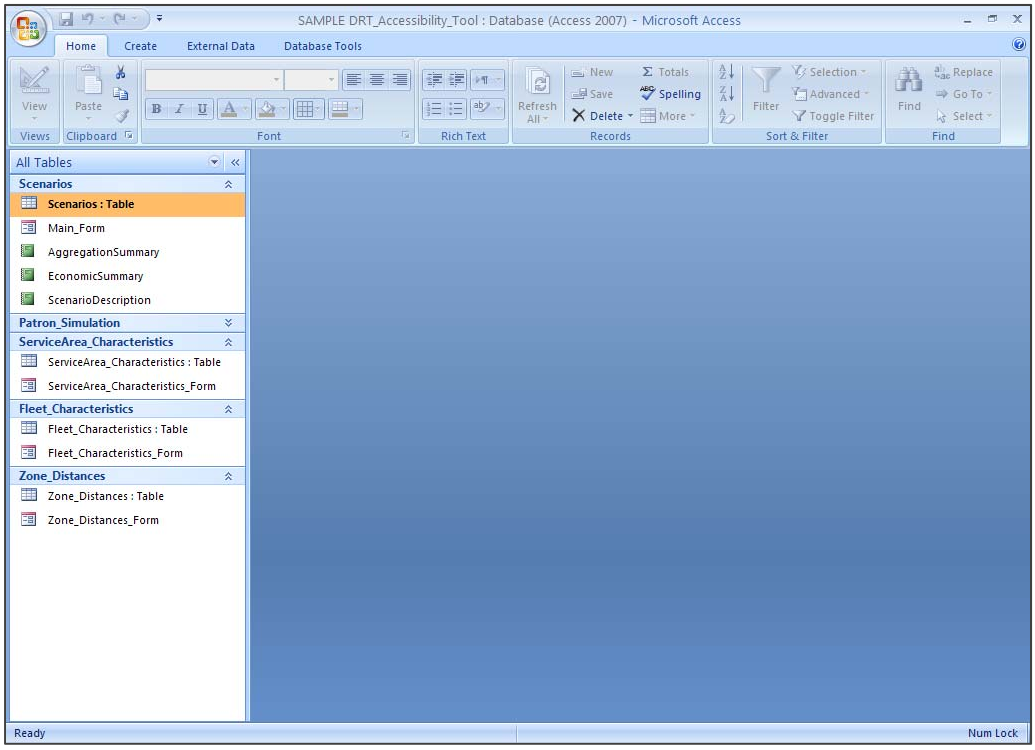
STEP 3: Open Tool

1. Double-click on the file you just pasted ("DRT Accessibility Tool.accdb"). This action will open the tool and Microsoft Access at the same time. (Alternatively, you may open Microsoft Access and navigate to the file you just pasted.)
2. On the "Security Warning" bar, click the box labeled "Options."



3. Select "Enable this content."

4. Click “OK.”
5. The DRT Accessibility Tool database application is now open.



3.2 ENTERING DATA

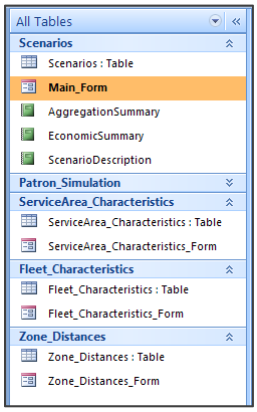
STEP 1: Formulate Tables in MS Excel

1. Refer to Section 2.3 for descriptions of the three required tables of data: service region characteristics, fleet characteristics, and zone distances.
2. Organize the data tables in Microsoft Excel. It is recommended that you use column names for each variable to ensure that all required variables are present and in the exact order presented in Section 2.3. It is further recommended that you use a separate tab for each table. In the Service Area Characteristics Table, each row should contain the information for a different zone. In the Fleet Characteristics Table, each row should contain information for a different vehicle. In the Zone Distances Table, each row should contain the distance between a different pair of zones. It is critically important to follow the exact formulation presented in Section 2.3. Any blank records or fields will result in an error. The following figure illustrates an example of the Zone Distances Table in Excel.

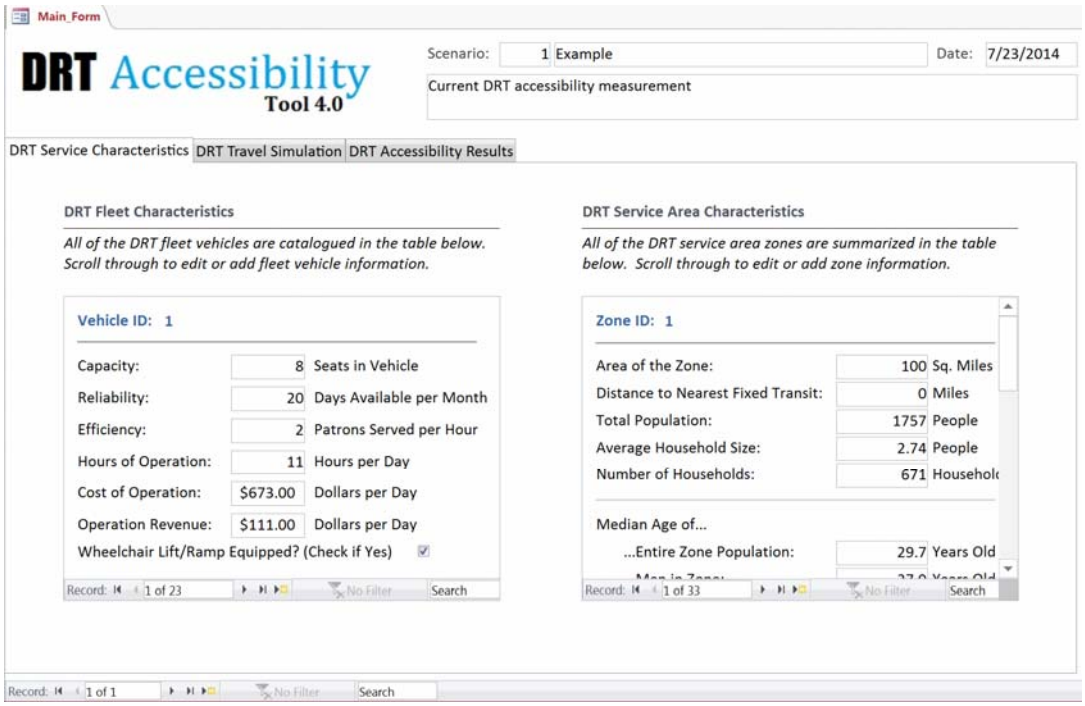
Scenario ID	Origin Zone	Destination Zone	Distance
1	1	2	0.5
1	1	3	3.4
1	2	1	0.5
1	2	3	10
1	3	1	3.4
1	3	2	10

STEP 2: Open Tool in MS Access

1. Refer to Section 3.1 if this is the first time the tool is being opened.
2. Otherwise, navigate to and double-click the file you saved entitled ‘‘DRT Accessibility Tool.accdb” to open the tool.
3. If the “Security Warning” box appears, click the box labeled “Options,” select “Enable this content,” and click “OK.”
4. Under the “Scenarios” header, double-click the form entitled “Main_Form.”

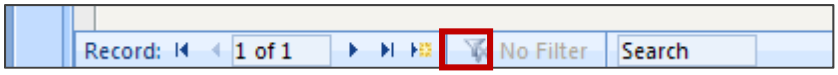


5. The Main Form is now open. The following figure illustrates what the Main Form will look like.

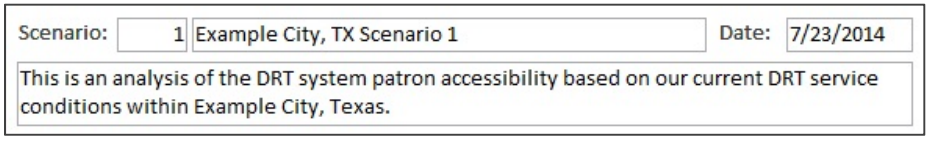


STEP 3: Create New Scenario

1. Start by going to the bottom of the Main Form to the Record toolbar. Click the icon highlighted in the red box in the following figure. This action opens a new scenario that you can edit. Confirm that the Scenario Number and Description fields at the top of the form are blank.



2. Start at the top of the Main Form by entering some descriptive information about the scenario that can be used to identify this specific evaluation. First, enter a number and name for the scenario. (The scenario number must be unique.) Confirm that this scenario number is the same as the *Scenario ID* from the data you just compiled. Next, enter the current date. Finally, enter a description of the scenario. The name and description provided here will also appear on the final data report.



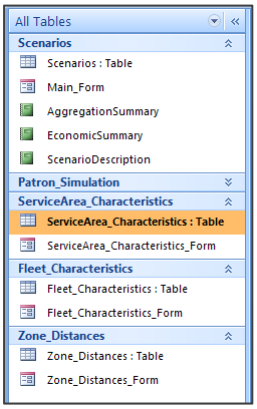
3. Close the Main Form.

STEP 4: Copy Service Area Characteristics Data

1. Return to the Excel spreadsheet that contains the Service Area Characteristics Table.
2. Highlight all the data within the table. Confirm that that all required variables are present and in the exact order presented in Section 2.3. Do not highlight the column names. Do not highlight any blank cells. In the example figure shown in Step 1, the data within the dark box is what should be selected.
3. Right-click the selection.
4. Click "Copy."

STEP 5: Paste Service Area Characteristics Data

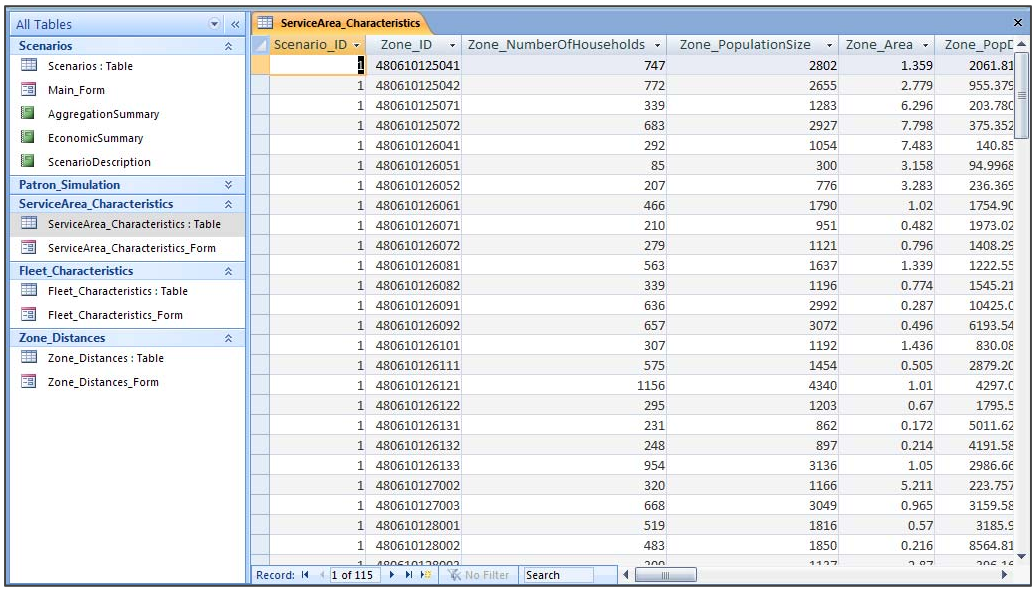
1. Return to the DRT Accessibility Tool in MS Access.
2. Double-click the table entitled "ServiceArea_Characteristics : Table" under the "ServiceArea_Characteristics" header in the Navigation Pane.



3. The Service Area Characteristics Table is now open.
4. Right-click on the asterisk located on the left of the last row in the table. The values in this row will be blank. If you have any scenarios already saved in the Tool, you will need to scroll past the service area records for the other scenario(s) to the bottom of the table to find the asterisk.

5. Click "Paste."

6. The service area characteristic data is now entered into the Tool. The following figure illustrates what the final table will look like.



7. Close the table.

STEP 6: Copy Fleet Characteristics Data

Similar to STEP 4.

STEP 7: Paste Fleet Characteristics Data

Follow the instructions in STEP 5 but double-click “Fleet_Characteristics : Table.”

STEP 8: Copy Zone Distances Data

Similar to STEP 4.

STEP 9: Paste Zone Distances Data

Follow the instructions in STEP 5 but double-click “Zone_Distances : Table.”

3.3 MEASURING ACCESSIBILITY

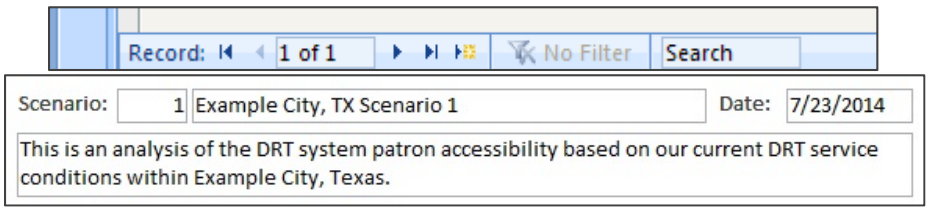
STEP 1: Open Tool in MS Access

1. Refer to Section 3.2 STEP 2.

STEP 2: Locate Scenario

1. Start by going to the bottom of the Main Form to the Record toolbar. Use the arrow buttons or search option to get to the preferred scenario. Use the scenario

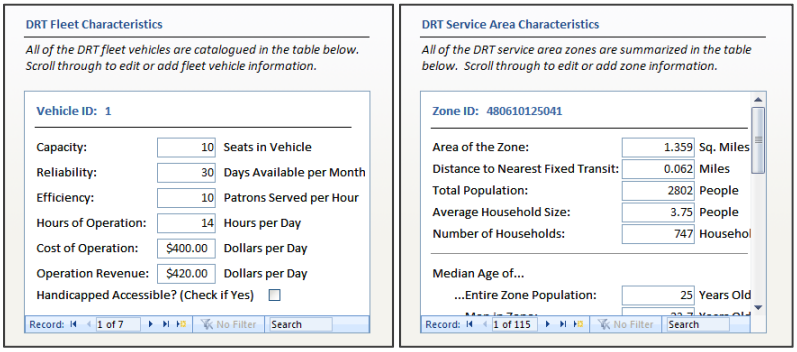
number, names, dates, and descriptions at the top of the Main Form to identify the correct scenario. Keeping the date constant allows for easy comparisons between scenarios.



2. When the correct scenario is located, proceed to STEP 3.

STEP 3: Confirm Data Is Entered

1. Click on the "DRT Service Characteristics" tab if it is not already selected. You should see two subheadings in this tab: "DRT Fleet Characteristics" and "DRT Service Area Characteristics." This tab presents the previously entered fleet and service area data in tables below the subheadings in a straightforward and easy-to-edit manner.

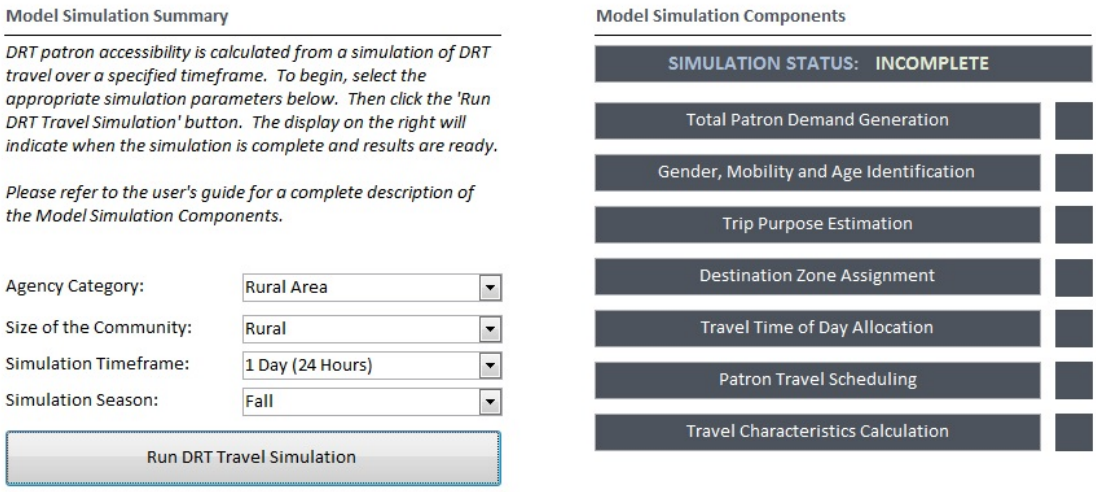


2. Confirm the DRT fleet and service area data are entered correctly by scrolling through all of the vehicles and zones using the arrow buttons on the Record toolbars embedded in this tab. Additionally, you may use the scrollbar to review more details about each of the DRT zones. In particular, be sure to confirm the following facts:
    a. The number of vehicles is correct.
    b. The number of service area zones is correct.
    c. All of the data is present for each vehicle.
    d. All of the data is present for each service area zone.

3. If any data is missing or incorrect, either edit it or go back and review the steps in Section 3.2 to make sure the data was entered correctly.
4. When all the data is present and correct, proceed to STEP 4.

STEP 4: Define Model Simulation Components

1. Click on the "DRT Travel Simulation" tab. You should see two components in this tab: "Model Simulation Summary" and "Model Simulation Components." In this tab you will simulate the DRT patron travel for which accessibility will be later measured. The "Model Simulation Summary" tab allows you to control the simulation components, and the "Model Simulation Components" tab tracks the progress of the simulation.



2. Choose the category of your agency from the "Agency Category" drop-down list. We provide five versions of the DRT Tool; each version is based on one of our five classifications of DRT service areas in Texas. Users should choose the version that best matches their service, based on the following descriptions of each DRT agency category:

Area Classification	DRT Agencies	Route Characteristics	Service Characteristics
Small areas	Cleburne, City of; CCART; Fort Bend County Rural Transit District; SCRPT; SPAN; The Transit System, Inc.; Galveston County Transit District.	-Area served < 1,000 sq. miles -Full coverage in most urban areas -Flexible route type in most areas	-Buses are more common than for other typology categories -Young fleet (less than 6 years on average) -Small fleet (less than 30 vehicles on average)
Medium areas	GCRPC; Kleberg County Human Services; Public Transit Services; RPMC; REAL	-Area served between 1,000 and 8,000 sq. miles -Full coverage in most urban areas -Flexible route type and route deviation	-Relatively late (8 AM) opening time -No service during weekends in most areas -Small vehicle capacity (12 seats per vehicle on average)
Large areas	AACOG; Brazos Transit District; Central Texas Rural Transit District; Hill Country Transit District; PCS; SPCAA; Southwest Area Regional Transit District; WTO	-Area served > 8,000 sq. miles -Flexible route type in most areas	-No service on Sundays; some agencies operate on Saturdays -Large fleet (more than 85 vehicles on average)
Rural areas	CARTS; Concho Valley Transit District; Del Rio, City of; ETCOG; STAR Transit; Texoma Area Paratransit System, Inc.	-Within rural areas only -Limited medical services provided -Operates a fixed route (non-DRT) service -Door-to-door service available in some areas -Variable days and hours of operation	-Some agencies offer partial urban coverage for medical purposes only -Old fleet (more than 7.5 years on average)
Non-Medicaid	ATCOG; BCAA; Colorado Valley Transit; CACST; Gulf Coast Center; HOTCOG; Lower Rio Grande Valley Development Council; SETRPC; Webb County Community Action Agency	-No service for Medicaid appointments -Flexible route type or route deviation -Door-to-door service not available in most areas	-Partial coverage in most urban areas -No service on Sundays; some agencies operate on Saturdays -Buses are not common

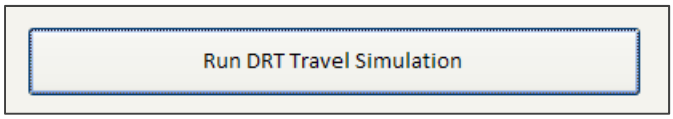
3. Choose the size of the community from the "Size of the Community" drop-down list. The options include urban, suburban, second city, town, and rural. This designation is used in the in-vehicle travel time calculation.
4. Choose the simulation time frame from the "Simulation Timeframe" drop-down list. The options include 1 Day (24 Hours), 3 Days (72 Hours), and 1 Week (7

days). This choice controls how many iterations the Tool will run: one, three, and seven iterations, respectively. The more iterations the Tool performs, the more precise the results. However, performing more iterations means that the Tool will take longer to run as well. Refer to Section 2.2.2 for more information on the implications of this decision.

5. Specify a season for this scenario from the "Simulation Season" drop-down list. The options include spring, summer, winter, and fall. This designation is used in the pickup time uncertainty and arrival time delay calculations.
6. When the components are selected, proceed to STEP 5.

STEP 5: Run DRT Travel Simulation

1. Continuing on the "DRT Travel Simulation" tab, click the "Run DRT Travel Simulation" button to start the simulation. It is recommended that you close all other programs before running the simulation, and that you do not attempt to do anything else with the Tool while the simulation is running. This may take anywhere from a few minutes to more than half an hour, depending on the size of your service region, number of iterations, and the computer's processing speed.

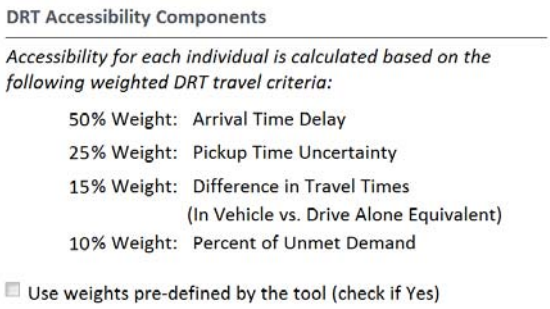


2. The Tool tracks the progress of the simulation under the "Model Simulation Components" subheading. Initially, the SIMULATION STATUS bar will read "INCOMPLETE." As the simulation runs, the SIMULATION STATUS bar will read "PROCESSING." Similarly, the Tool will indicate when each simulation component is completed by turning the dark square next to that component green. Once the simulation is started, there is no way to stop it except for closing down MS Access.
3. When the simulation is complete, the SIMULATION STATUS bar will read "COMPLETE." The "Model Simulation Components" subheading will look like the following figure. It is important to recognize that the Tool always stores the results from the last simulation run. If you would like to run the simulation again, it will overwrite the current results. Either way, because the results are permanently stored, you can close the Tool and come back and view the results at any time.

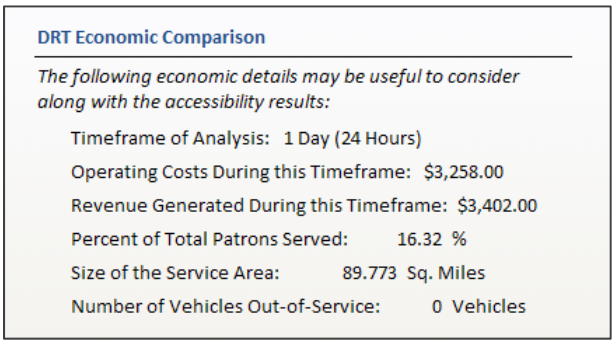
4. When the SIMULATION STATUS bar reads "COMPLETE," proceed to STEP 6.

STEP 6: Define DRT Accessibility Aggregation Scheme

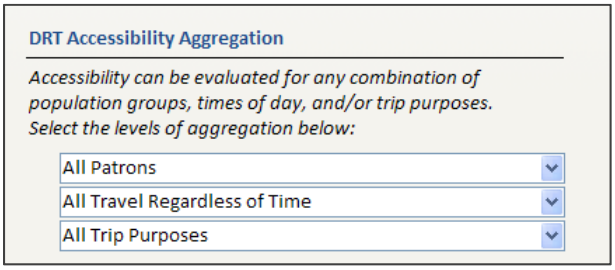
1. Click on the "DRT Accessibility Results" tab. You should see four components in this tab: "DRT Accessibility Components," "DRT Economic Comparison," "DRT Accessibility Aggregation," and "DRT Accessibility Results." This tab summarizes accessibility, the scenario, and aggregation.
2. Accessibility for each individual is measured based on the weighted DRT travel criteria presented under the "DRT Accessibility Components" subheading. You can check the box at the bottom of this component if you want to use weights that are predefined based on DRT patron survey results. If you would like to change the weights based on findings from your own area, you can edit them by clicking on each. If you are changing these weights, it is important to recognize that these weights need to sum to 100% for the accessibility measure to be accurate.



3. The “DRT Economic Comparison” subheading provides context when reviewing the DRT accessibility results. These details are calculated as part of the simulation and reflect the simulated patron travel. These values cannot be changed.



4. In order to review results, you must first select an aggregation scheme. Start by selecting the “Population Aggregation” from the drop-down list. Options include all the possible combinations between the three population dimensions: gender, age, and mobility condition. Make sure you click each list at least once even though the default option is what you want.

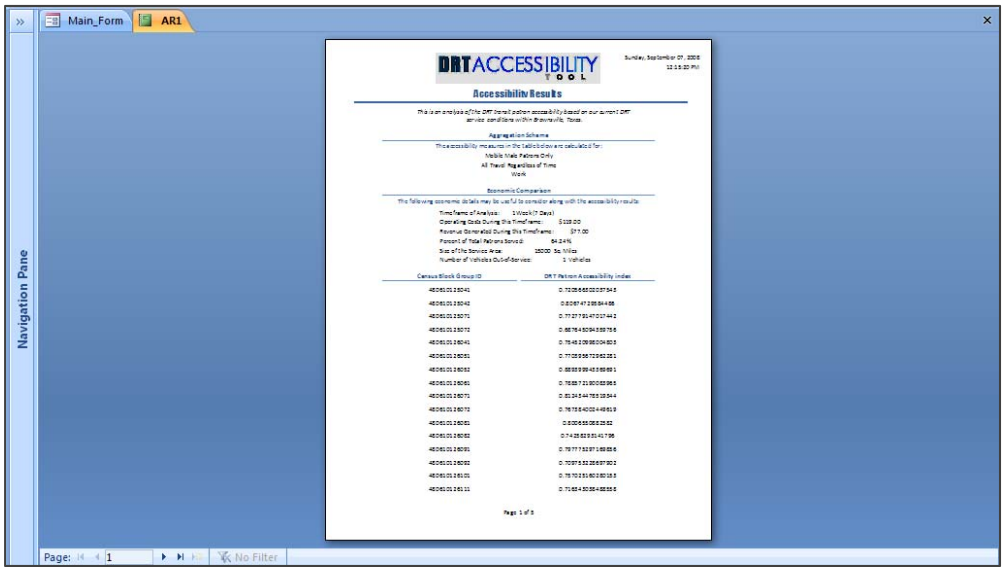


5. Select the “Time Of Day Aggregation” from the drop-down list. Options include travel begun in the AM and ending in the AM, travel begun in the AM and ending in the PM, travel begun in the PM and ending in the PM, travel begun in the AM regardless of end time, travel ending in the PM regardless of start time, and all travel regardless of time.
6. Select the “Trip Purpose Aggregation” from the drop-down list. Options include education/school, recreation, medical/therapy, shopping, work, and all trip purposes.

7. Only when all three aggregation levels are selected does the button to review results appear under the "DRT Accessibility Results" subheading. When it is visible, click the button to review the results and proceed to STEP 7.

STEP 7: Review DRT Accessibility Results

1. The DRT accessibility results (based on the aggregation scheme entered in the Main Form) are presented in a report similar to the one presented in the following figure. This report opens in a new Print Preview tab, and it includes the scenario description, aggregation scheme, economic comparison, and accessibility results for each service area zone. The accessibility results are structured so that there is one DRT Patron Accessibility Index value for each service area zone between 0 and 1, with 1 representing high accessibility. Service area zones are ordered numerically.
    a. The accessibility displayed is the average accessibility for patrons matching the aggregation scheme within the zone.
    b. If the index is blank, this means that there are no patrons that match the aggregation scheme within the zone.



2. You can navigate through the pages of the report using the arrow buttons on the Page toolbar at the bottom of the report.

3. You can print the report by clicking the Print button at the top left corner of the page.
4. It is important to note that it is not possible to save this report since it is based on a temporary query. However, you can reopen it anytime by returning to the Main Form, selecting the same aggregation scheme, and opening the report. The simulation data for each scenario is saved in the Tool so you do not need to run the simulation every time you want to review results.
5. When you are done, close the report.

3.4 PRESENTING RESULTS IN ARCGIS

STEP 1: Retrieve Accessibility Results

1. Refer to STEP 6 and STEP 7 in Section 3.3.

STEP 2: Create Map of Service Region

1. Open ArcGIS.
2. If you already have a map created of the service area zones from when you created that data, open that existing map. Otherwise, check "A new empty map," click "OK," click the Add Data button, and navigate to add the service area zones shapefile to the map.

STEP 3: Open Attribute Table

1. Right-click the service area layer/shapefile on the Layer List.
2. Click "Open Attribute Table."
3. This opens the attribute table for the service area zones.

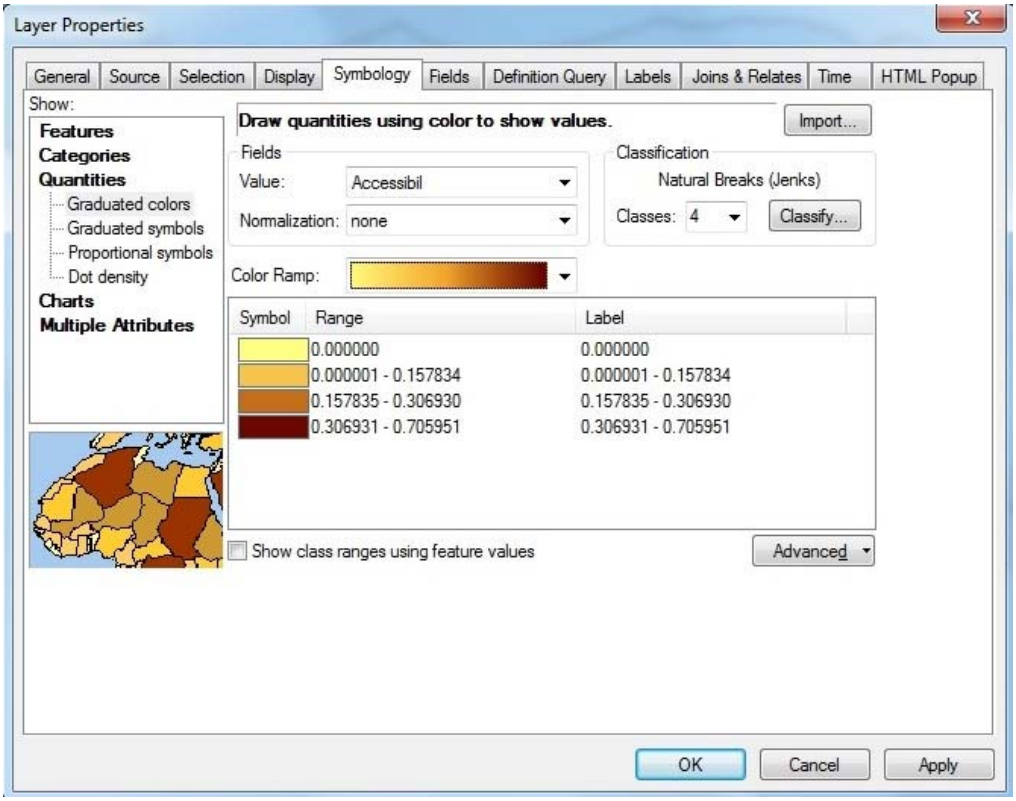
STEP 4: Edit Data

1. Click the "Options" button at the bottom of the attribute table.
2. Click "Add Field…".
3. Type "Accessibility" (without quotes) into the "Name" space.
4. Choose "Double" as the "Type."
5. Click "OK."
6. Right-click the field column name for the service area zone IDs.
7. Click "Sort Ascending."
8. Click the "Editor" button at the top of the screen.

9. Select the folder containing the shapefile to edit and click “Start Editing.”
10. On the attribute table, scroll to the new field labeled “Accessibility.”
11. Refer to the printed report from the DRT Accessibility Tool. Enter the appropriate DRT Patron Accessibility Index value for each service area zone.
12. When all the values are entered, click the “Editor” button.
13. Click “Stop Editing” and “Yes” when the dialog box asks to save edits.

STEP 5: Create Color Theme

1. Right-click the service area layer/shapefile on the Layer List.
2. Click “Properties…”.
3. Click the “Symbology” tab.



4. Set “Fields’ Value” as “Accessibility” and “Normalization” as “None.”
5. Set “Classification” as “Natural Breaks (Jenks)” with four classes. This means that you will be dividing the service area zones into four quartiles based on accessibility measures.
6. Choose a color pattern from the “Color Ramp.”

7. Edit the labels so that the lowest “Range” is “High Accessibility” and the highest “Range” is “Low Accessibility.” Label the two ranges in between as “Average High Accessibility” and “Average Low Accessibility.” Those with 0 should be labeled “No Patrons.”
8. Click “OK.” The map now presents the accessibility results ranked in four quartiles.

4. TOOL APPLICATIONS

System operators can use the Accessibility Tool for two main planning applications. First, they can evaluate their current accessibility levels for various combinations of population groups, service areas, and travel purposes. Second, the Tool allows system operators to undertake "what if?" scenarios to evaluate changes in fleet characteristics (supply), population demographics (demand), and service areas (scope).

4.1 BENCHMARKING ACCESSIBILITY

Much of the previous literature is focused on methods for benchmarking current practices, and the Tool provides detailed benchmarking measures of accessibility that can be compared over time. Furthermore, system operators can measure accessibility spatially on a regional scale or focus on specific population groups/times/trip purposes to identify areas that need more reliable service or on specific population groups that need to be targeted. Figure 4 illustrates an application of the DRT Accessibility Tool to study general DRT accessibility in Brownsville, Texas. The lightest census block groups are in the quartile identified as best serving patrons needs. As the census block group coloring gets darker, the level of patron accessibility diminishes. System operators and planners can use maps such as this one to locate areas where DRT service may need to be improved or further studied.

Benchmarking can be accomplished with the Tool by creating different scenarios for the DRT system over time. By having multiple scenarios (instead of just changing the data for a single scenario), users can compare accessibility for different aggregation schemes over time. Users can use the Tool to methodically document growth and identify accessibility trends. The ability to show benchmarks such as this will become increasingly important in the near future as funding relies more on these indicators.

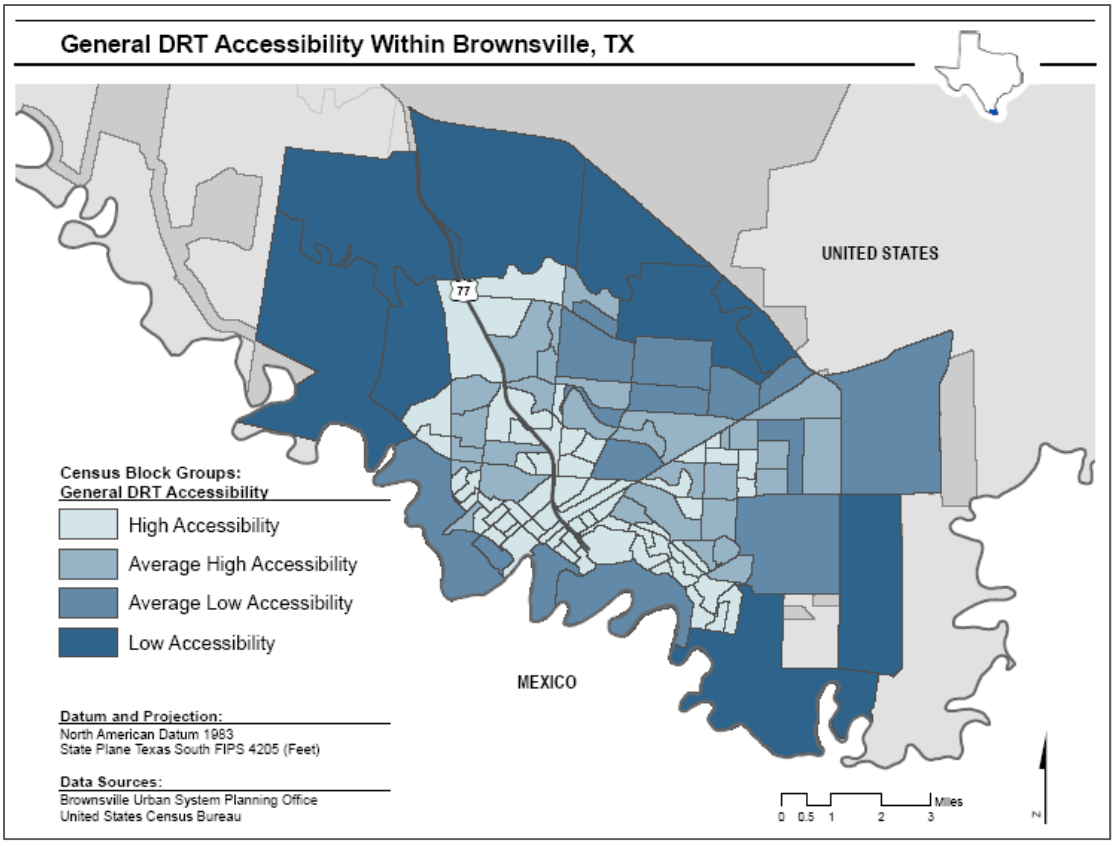


Figure 4: General DRT Accessibility within Brownsville, TX

4.2 "What If?" SCENARIOS

More importantly, however, is the ability to conduct "what if?" scenarios to evaluate changes in fleet characteristics (supply), population demographics (demand), and service areas (scope). For example, the Tool allows an operator to calculate the impact of adding an additional vehicle or expanding the service region on patron DRT accessibility. Similarly, system operators can predict (and anticipate) future needs of their riders by using the Tool to analyze changes in population demographics. System operators have the option of saving these scenarios for future comparison as well. These results have the potential to inform a range of public transportation planning, budgetary, and policy decisions. For example, purchasing an additional wheelchair lift or ramp-equipped vehicle might be justified if mobility-impaired patron accessibility levels show a significant improvement with the addition of this vehicle. The Tool provides many such robust opportunities for the planner to see how any changes may impact transit operation. These "what if?" scenarios will become increasingly important as these small and medium-sized communities continue to develop.

To further assist system operators in evaluating “what if?” scenarios, the Tool also provides economic information related to each scenario. This information, which is presented in the “DRT Accessibility Results” tab and report, is calculated as part of the DRT travel simulation and offers context when reviewing the DRT accessibility results. For example, consider two scenarios that both improve overall patron accessibility roughly the same amount. Clearly the scenario that increases generated revenue should be the preferred alternative.

Figure 5 illustrates one such “what if?” scenario: the impact that adding an additional vehicle to the fleet has on male DRT patron accessibility. In this example, adding an additional vehicle does not have a drastic impact on the entire service area’s accessibility for male patrons. However, a significant number of zones increased their average accessibility measures for male patrons. A few zones decreased in accessibility as well, but since the accessibility measures are relative indices, there will always be a slight downward shift of accessibility in some zones to balance out the upward shift of accessibility in other zones. In this instance, however, the additional capacity had an overall positive effect, as the number of upward shifts significantly outweighs the number of downward shifts. Users could continue the “what if?” analysis by adding additional vehicles until there was little or no change to the accessibility measures. In doing this, system operators could identify the optimum fleet size limit. System operators could also conduct a similar “what if?” analysis to determine the impact that improved vehicle efficiency would have on male DRT patron accessibility. After identifying the most efficient scenario, they could then compare the economic factors for the increased fleet size and improved efficiency alternatives to find the best option. The Tool can conduct any possible “what if?” scenarios that system operators and planners would need.

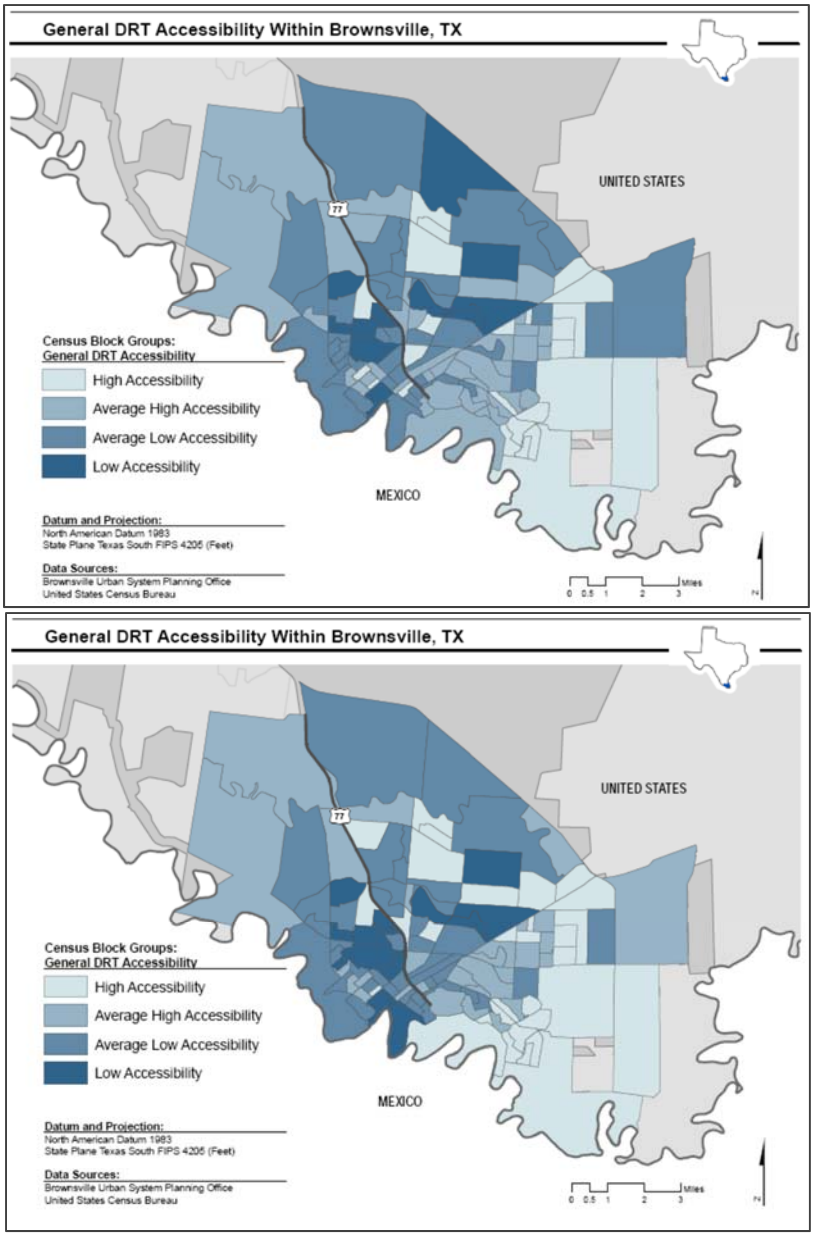


Figure 5: General Male DRT Accessibility within Brownsville, TX, Before and After Adding an Additional Fleet Vehicle

5. ADDITIONAL INFORMATION

5.1 TECHNICAL SUPPORT

The research team is available for:

- Feedback on how to improve the software
- Technical support in using the software
- Technical support in collecting required data
- General information

If you would like to contact the team, please address queries to the research supervisor, Dr. Chandra R. Bhat.

Email: bhat@mail.utexas.edu
Phone: (512) 471-4535
Fax: (512) 475-8744

THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

0-6768-P3

DRT Accessibility Tool Workshop Materials

TxDOT Project 0-6768: Development of an Accessibility Formulation to Measure Customers' Evaluations of Demand Responsive Transit (DRT) Systems

AUGUST 2014; PRINTED MARCH 2017

Performing Organization: Center for Transportation Research The University of Texas at Austin 1616 Guadalupe, Suite 4.202 Austin, Texas 78701	**Sponsoring Organization:** Texas Department of Transportation Research and Technology Implementation Office P.O. Box 5080 Austin, Texas 78763-5080
Performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.	

THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

Development of an Accessibility Formulation to Measure Customers' Evaluations of Demand Responsive Transit (DRT) Systems

August 22, 2014

Demand Responsive Transit Accessibility Tool

What can I obtain from the tool?

You can **evaluate** your Demand Responsive Transit (DRT) system in terms of:

- ❑ Operating costs
- ❑ Generated revenue
- ❑ Number of patrons served
- ❑ Service area size
- ❑ **Accessibility levels** for various combinations of population groups, times of day, and travel purposes

How can I analyze the results?

- ❑ Undertake **"what if?" scenarios** to evaluate changes in:
  - fleet characteristics (supply),
  - population demographics (demand),
  - and service areas (scope)
- ❑ Predict (and anticipate) future needs of your riders by using the tool to analyze the impact of changes in population demographics.

Demand Responsive Transit Accessibility Tool

What do I need to run the tool?

Run the tool using almost any reasonable-equipped computer if you have:

- ❑ **Microsoft Access**
- ❑ **Data about your fleet** such as number of vehicles, capacity of the vehicles, hours of operation, handicapped facilities, daily cost operation, daily revenue, etc.
- ❑ **Data about your service area** (*optional:* alternatively you can just use the data that we have collected around the entire Texas) such as community size, land use zoning, census demographics, distances between zones, etc.

Background

- Demand responsive transit (*DRT*)
- Transit Accessibility: A Customer's Perspective
  - Senior citizens, reduced mobility, low income

- TxDOT sponsored projects (0-5178 and 5-5178) developed a DRT accessibility tool for Brownsville
  - DRT is important in Texas: 177 of 254 counties are rural and over 15% of the population lives in rural areas (U.S. Census, 2010)
  - Texas has 39 rural transit districts

Objective

- To develop demand models for DRT systems for all Texas providers

(1) Develop a typology for DRT providers within the context of their service area and fleet characteristics

(2) Update DRT accessibility tool (customized for each typology category)

Step1: Developed a TYPOLOGY

Category No.	Category label	Category characterization	
		Main characteristics	**Secondary characteristics**
1	Small areas	- Area served < 1,000 sq. miles - Full coverage in most urban areas - Flexible route type in most areas	- Buses are more common than for other typology categories - Young fleet (< 6 years on average) - Small fleet (< 30 vehicles on average)
2	Medium areas	- Area served between 1,000 - 8,000 sq. miles - Full coverage in most urban areas - Flexible route type and route deviation	- Relatively late (8am) opening time - No weekend service in most areas - Small vehicle capacity (12 seats per vehicle on average)
3	Large areas	- Area served > 8,000 sq. miles - Flexible route type in most areas	- No Sunday service, some agencies operate on Saturdays - Large fleet (> 85 vehicles on average)
4	Rural areas	- Within rural areas only - Limited medical services provided - Operates a fixed route (non DRT) service - Door-to-door service available in some areas - Variable days and hours of operation	- Some agencies offer partial urban coverage for medical purposes only - Old fleet (> 7.5 years on average)
5	Non-medicaid	- No service for medicaid appointments - Flexible route type or route deviation - Door-to-door service not available in most areas	- Partial coverage in most urban areas - No Sunday service, some agencies operate on Saturdays - Buses are not common

Step 2: Selected Prototypical Agencies

Category No.	Category label	Prototypical Agency	Counties served
1	Small Areas	Fort Bend County Rural Transit District	Fort Bend
2	Medium Areas	Public Transit Services	Jack, Palo Pinto and Parker
3	Large Areas	Hill Country Transit District	Mason, San Saba, Llano, Mills, Lampasas, Hamilton, Coryell, Bell and Milam
4	Rural Areas	City of Del Rio	Val Verde
5	Non-Medicaid	Bee Community Action Agency (BCAA)	Mc Mullen, Live Oak, Bee, Refugio and Aransas

Step 3: Collected data

- Demographic
  - Population
  - Area
  - Age
  - Household Size
  - Distances
  - Land Use
- Vehicle Fleet
  - Capacity
  - Availability
  - Daily cost
  - Daily revenue
  - Mobility-impaired facility
  - Age
- Demand (trips)
  - Origin zone
  - Destination zone
  - Pick-up time
  - Arrival time
  - Whether or not the passenger is mobility-impaired
  - Purpose

Step 4: Input data into Tool

Module 1: Service Characteristics

Fleet Characteristics

Number of Vehicles
Vehicle Capacities
Fleet Reliability
Trip Efficiency
Hours of Operation
Handicapped-Ready
Daily Cost of Operation
Daily Revenue

Service Area Characteristics

Community Size
Census Block Groups
Land Use Zoning
Demographics
Distances to Transit
Distances Between Zones

Module 2: Demand Responsive Transit Travel Simulation

Total Patron Demand Generation

⇩

Gender, Mobility and Age Identification

⇩

Trip Purpose Estimation

⇩

Destination Zone Assignment

⇩

Time of Day Allocation

⇩

Patron Travel Scheduling

⇩

Travel Characteristics Calculation

In Vehicle Travel Time
Drive Alone Equivalent Travel Time
Pickup Time Uncertainty
Arrival Time Delay

Module 3: Accessibility Index

Accessibility Index

Pickup Time Uncertainty
Arrival Time Delay
Difference in Travel Times
Percent of Unmet Demand

Aggregation Schemes

Population Groups
Times of Day
Trip Purposes
Spatial Areas

Economic Comparison

Timeframe
Operating Costs
Generated Revenue
Number Patrons Served
Service Area Size

About the Accessibility Index

- Level of accessibility experienced by patrons is calculated based on four relevant travel characteristics:
  - Number of minutes late a patron arrives at her or his destination.
  - The time difference (in minutes) between when a patron was scheduled to be picked up and when he/she actually was picked up.
  - Difference in minutes between the time a patron spends in the DRT vehicle and the equivalent time it would have taken if he/she was able to drive a personal vehicle.
  - Percentage of the patrons who could not be scheduled during this period in the patron's originating zone.
- Accessibility is obtained as the weighted sum of the above four characteristics, and then is normalized (1 is the highest and 0 is the lowest)
- Specific values of 'weights' obtained from a patron survey

Step 5: Create different version of the Tool for each Typology Category

DRT Accessibility Tool 4.0

Scenario: 1 Example Date: 7/23/2014

Current DRT accessibility measurement

DRT Service Characteristics | DRT Travel Simulation | DRT Accessibility Results

DRT Fleet Characteristics

All of the DRT fleet vehicles are catalogued in the table below. Scroll through to edit or add fleet vehicle information.

Vehicle ID: 1

Capacity:	8	Seats in Vehicle
Reliability:	20	Days Available per Month
Efficiency:	2	Patrons Served per Hour
Hours of Operation:	11	Hours per Day
Cost of Operation:	$673.00	Dollars per Day
Operation Revenue:	$111.00	Dollars per Day
Wheelchair Lift/Ramp Equipped? (Check if Yes)	☑	

Record: 1 No Filter Search

DRT Service Area Characteristics

All of the DRT service area zones are summarized in the table below. Scroll through to edit or add zone information.

Zone ID: 1

Area of the Zone:	100	Sq. Miles
Distance to Nearest Fixed Transit:	0	Miles
Total Population:	1757	People
Average Household Size:	2.74	People
Number of Households:	671	Household
Median Age of...		
...Entire Zone Population:	29.7	Years Old

Record: 1 No Filter Search

DRT Accessibility Tool 4.0

Scenario: 1 Example Date: 7/23/2014

Current DRT accessibility measurement

DRT Service Characteristics | DRT Travel Simulation | DRT Accessibility Results

Model Simulation Summary

DRT patron accessibility is calculated from a simulation of DRT travel over a specified timeframe. To begin, select the appropriate simulation parameters below. Then click the 'Run DRT Travel Simulation' button. The display on the right will indicate when the simulation is complete and results are ready.

Please refer to the user's guide for a complete description of the Model Simulation Components.

Agency Category:	Rural Area
Size of the Community:	Rural
Simulation Timeframe:	1 Day (24 Hours)
Simulation Season:	Fall

Run DRT Travel Simulation

Model Simulation Components

SIMULATION STATUS: INCOMPLETE

- Total Patron Demand Generation
- Gender, Mobility and Age Identification
- Trip Purpose Estimation
- Destination Zone Assignment
- Travel Time of Day Allocation
- Patron Travel Scheduling
- Travel Characteristics Calculation

DRT Accessibility Tool 4.0

Scenario: 1 Example Date: 7/23/2014

Current DRT accessibility measurement

DRT Service Characteristics | DRT Travel Simulation | DRT Accessibility Results

DRT Accessibility Components

Accessibility for each individual is calculated based on the following weighted DRT travel criteria:

50 % Weight: Arrival Time Delay

25 % Weight: Pickup Time Uncertainty

15 % Weight: Difference in Travel Times (In Vehicle vs. Drive Alone Equivalent)

10 % Weight: Percent of Unmet Demand

☑ Use weights pre-defined by the tool (check if Yes)

DRT Accessibility Aggregation

Accessibility can be evaluated for any combination of population groups, times of day, and/or trip purposes. Select the levels of aggregation below:

Male Patrons Only

Travel Begun in the AM and Ending in the AM

All Trip Purposes

DRT Economic Comparison

The following economic details may be useful to consider along with the accessibility results:

Timeframe of Analysis: 1 Day (24 Hours)

Operating Costs During this Timeframe: $10,095.00

Revenue Generated During this Timeframe: $1,665.00

Percent of Total Patrons Served: 27.92 %

Size of the Service Area: 3300 Sq. Miles

Number of Vehicles Out-of-Service: 8 Vehicles

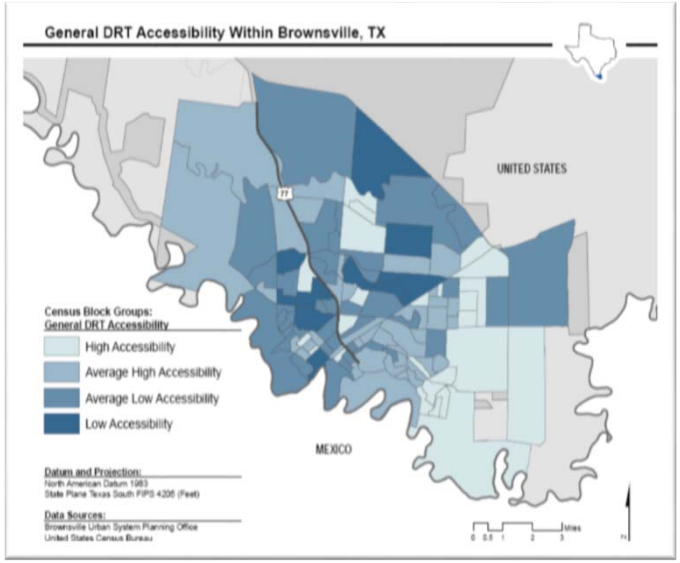
DRT Accessibility Results

Once the accessibility components and aggregation are selected, click the button below to review the accessibility results for each service area zone.

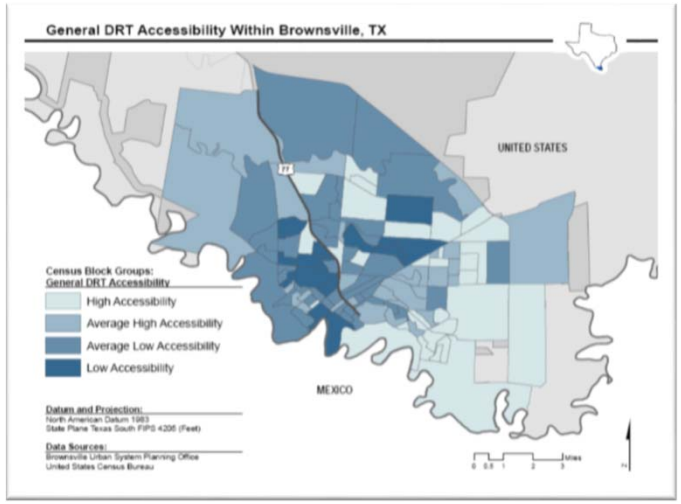
Use Tool to Analyze "what if?" Scenarios

- Policy changes
  - Medical/medicare changes
  - Social security changes
  - Fleet composition changes
  - Agency requirement changes
- Development and growth
  - Land use
  - Economic development
  - Implementation of new transport system
- Travel patterns
  - Seasonal trips effect
  - Shopping trips effect
  - Emergency situations
- Demographic and operations
  - Population Increase
  - Change in vehicle fleet

Before

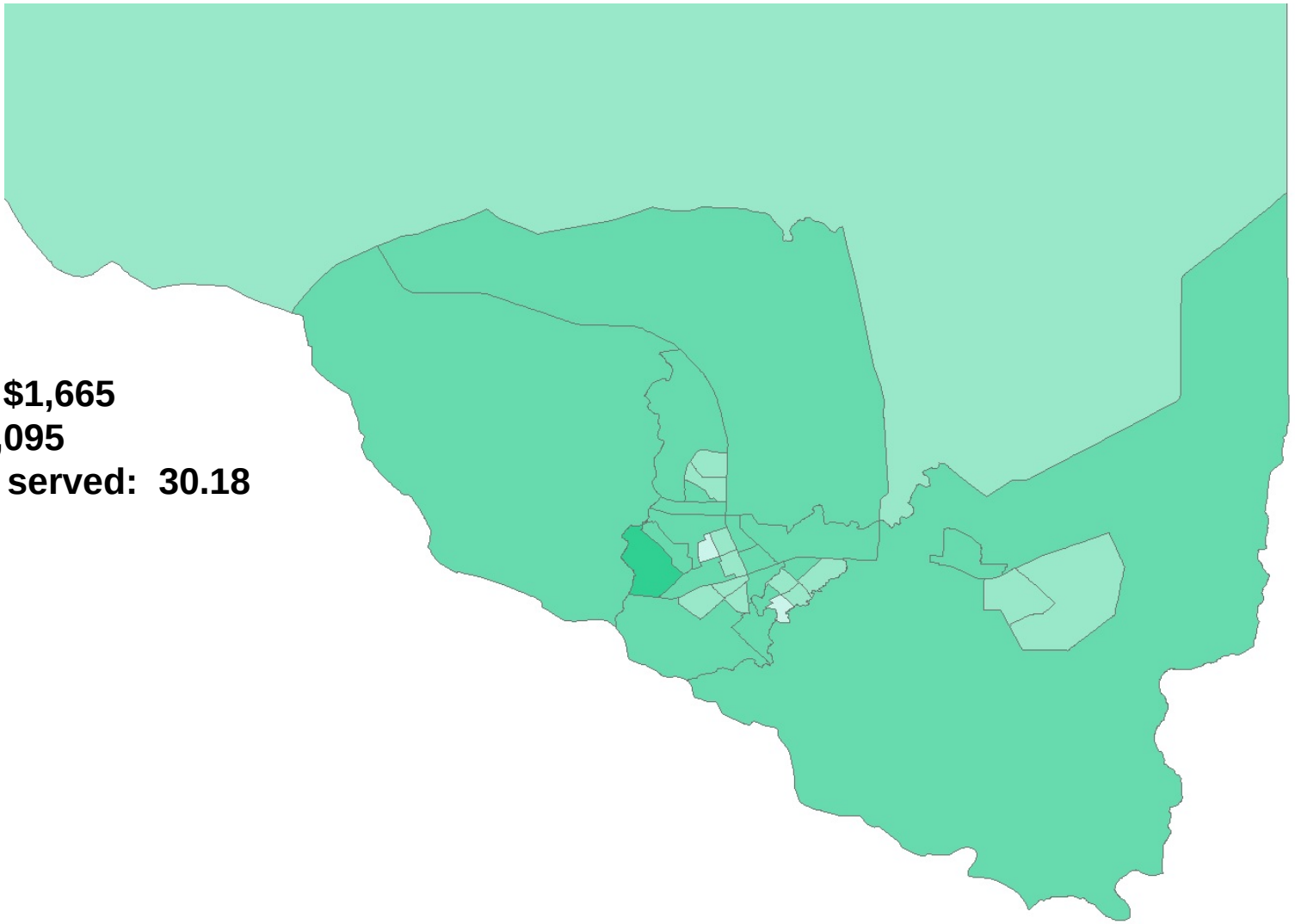


After



Example: one additional vehicle

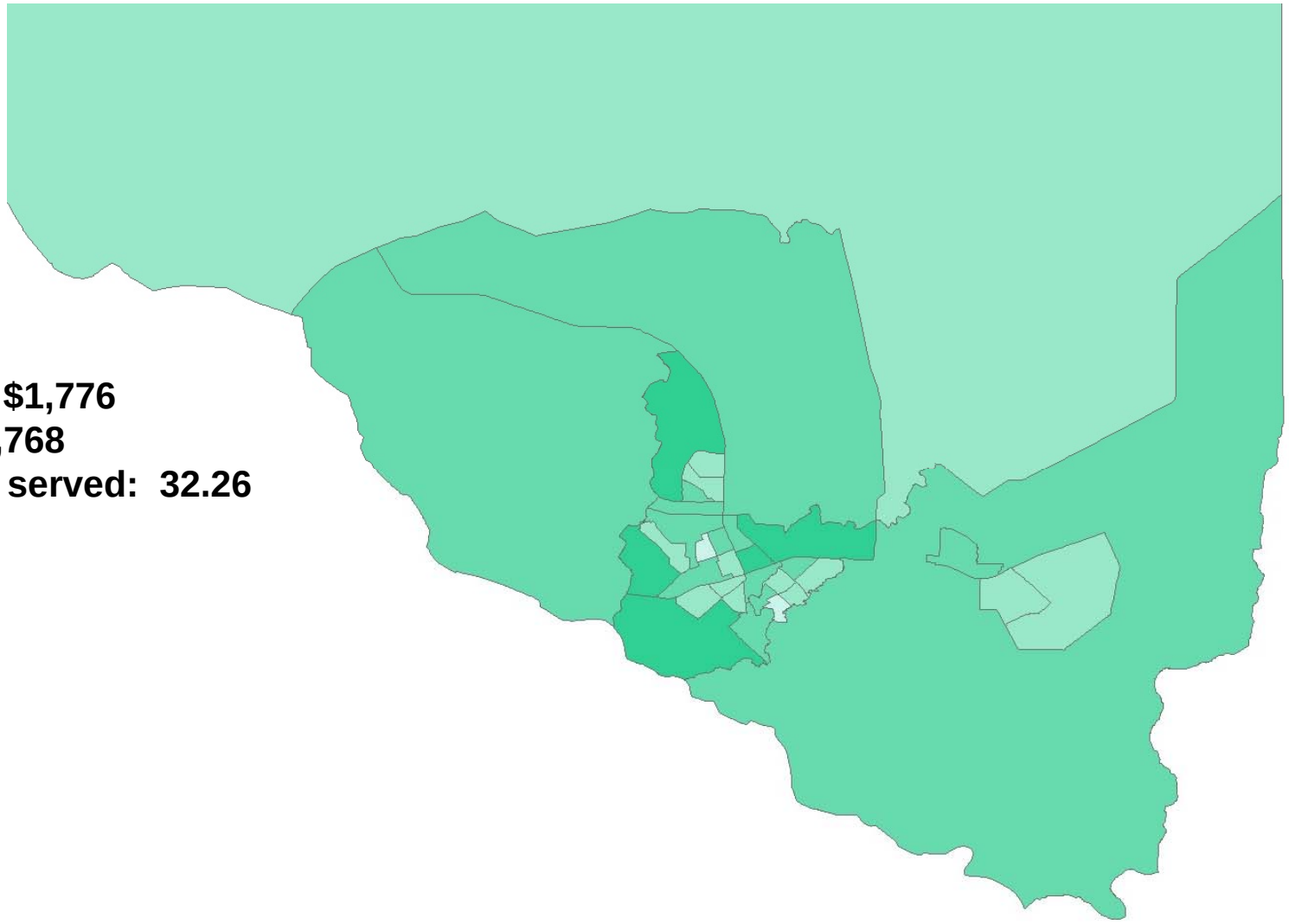
Before



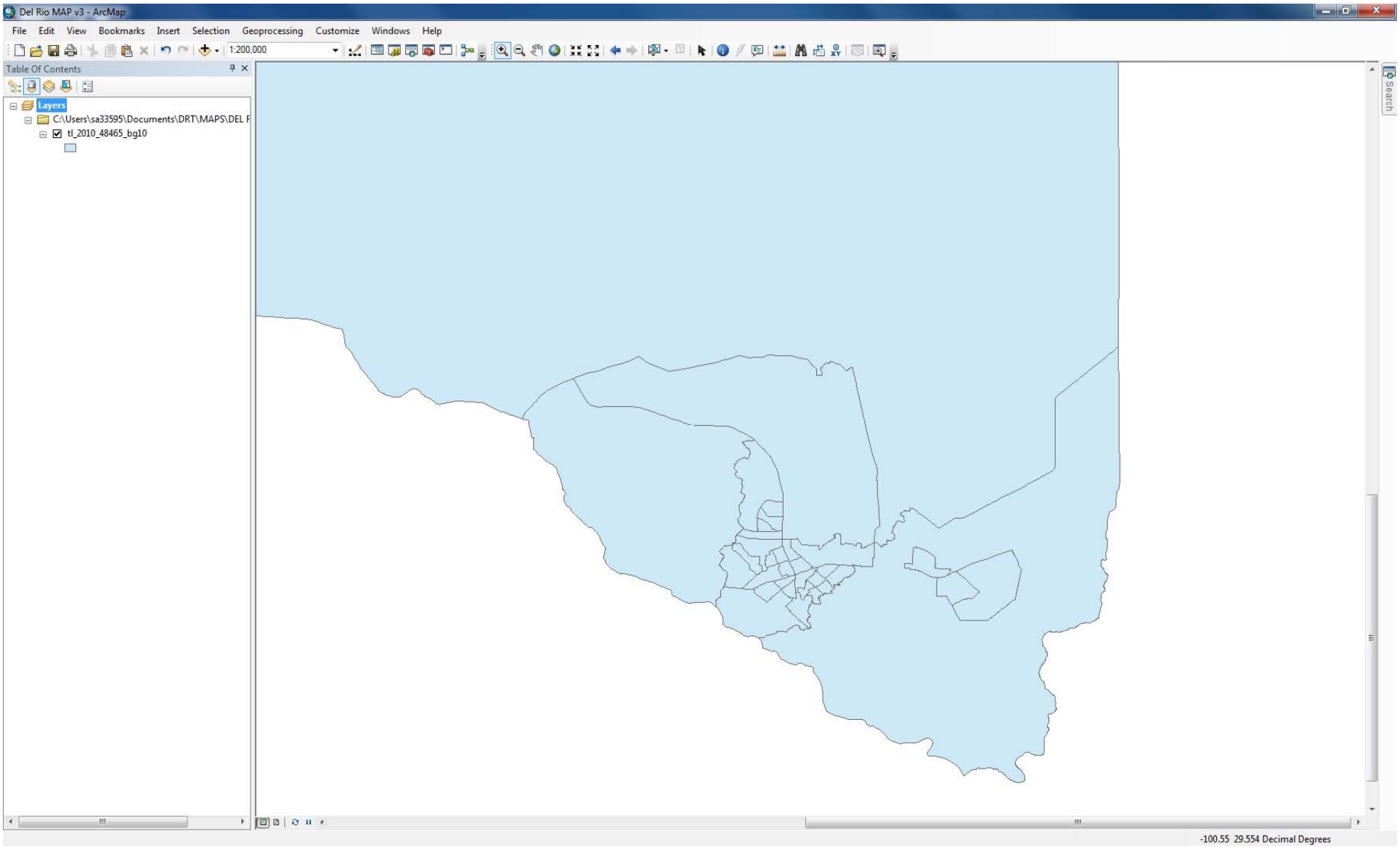
Revenue: $1,665
Cost: $10,095
% Patrons served: 30.18

Example: one additional vehicle

After



Revenue: $1,776
Cost: $10,768
% Patrons served: 32.26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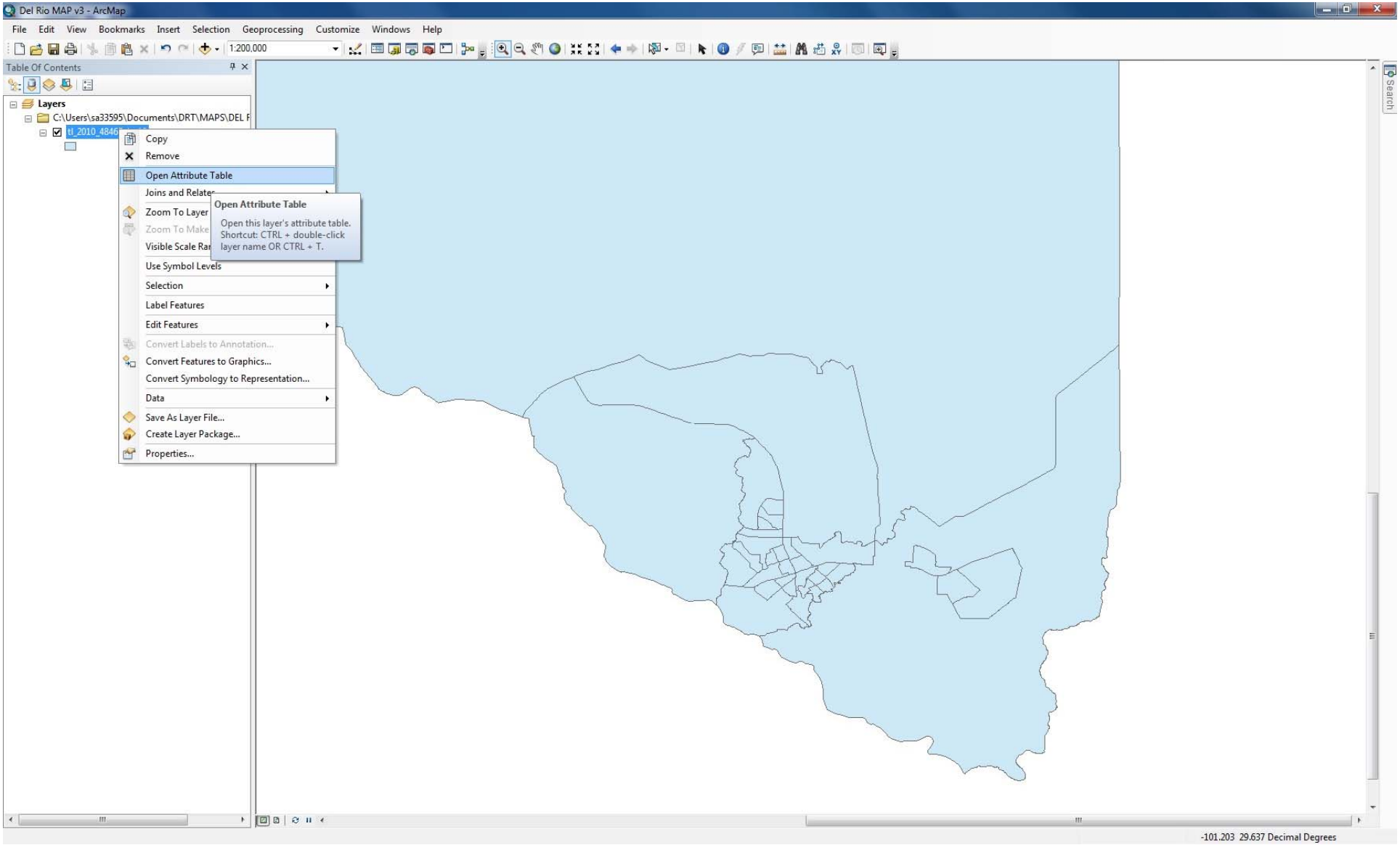
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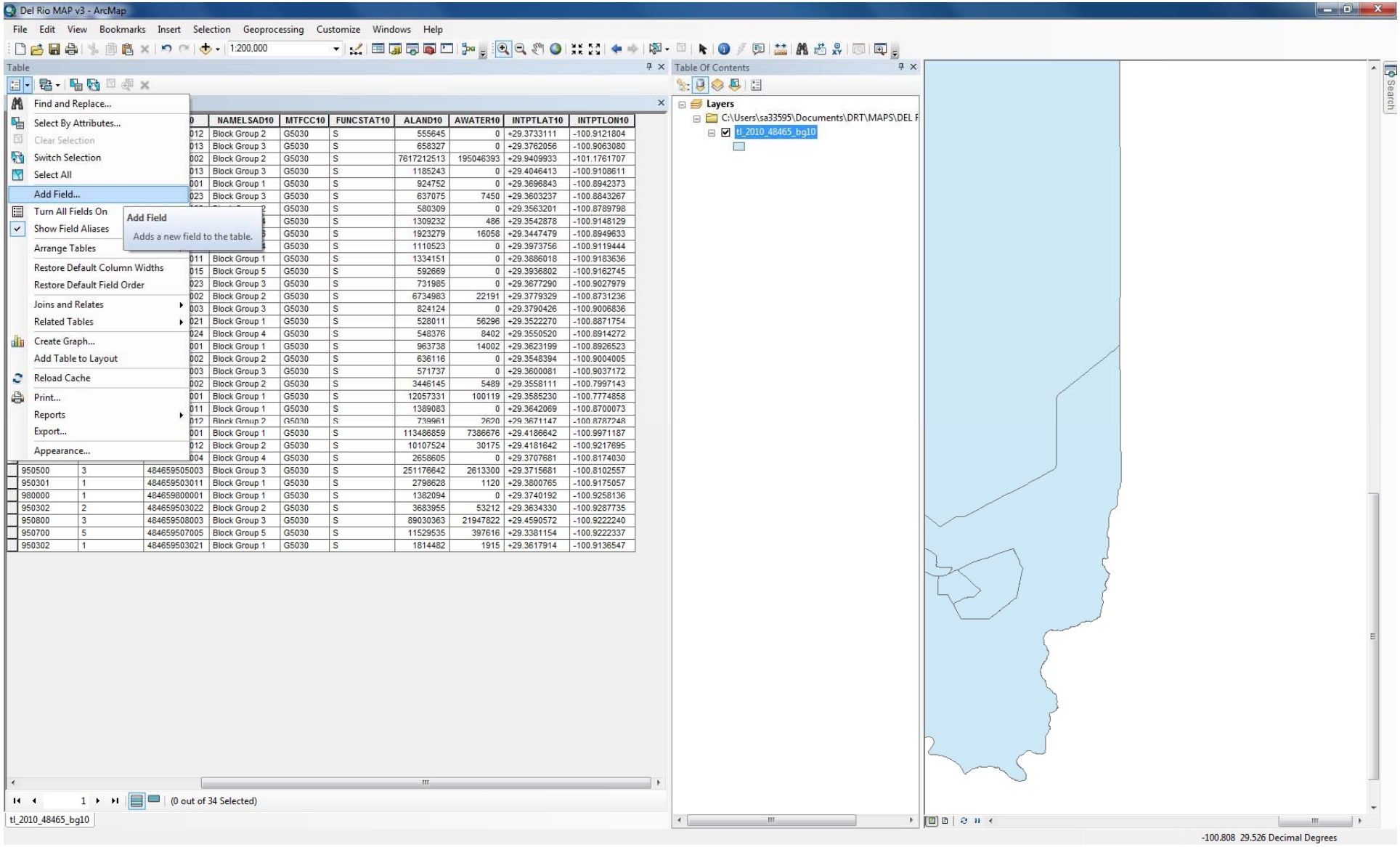
Remove
Open Attribute Table
Joins and Relates
Zoom To Layer
Zoom To Make
Visible Scale Ra
Use Symbol Levels
Selection
Label Features
Edit Features
Convert Labels to Annotation...
Convert Features to Graphics...
Convert Symbology to Representation...
Data
Save As Layer File...
Create Layer Package...
Properties...
Open Attribute Table
Open this layer's attribute table.
Shortcut: CTRL + double-click
layer name OR CTRL + T.
Search
-101.203 29.637 Decimal Degrees


Del Rio MAP v3 - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:200,000
Table
Find and Replace...
Select By Attributes...
Clear Selection
Switch Selection
Select All
Add Field...
Turn All Fields On
Show Field Aliases
Arrange Tables
Restore Default Column Widths
Restore Default Field Order
Joins and Relates
Related Tables
Create Graph...
Add Table to Layout
Reload Cache
Print...
Reports
Export...
Appearance...
Add Field
Adds a new field to the table.
NAMELSAD10 MTFCC10 FUNCSTAT10 ALAND10 AWATER10 INTPTLAT10 INTPTLON10
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950301 1 484659503011 Block Group 1 G5030 S 2798628 1120 +29.3800765 -100.9175057
980000 1 484659800001 Block Group 1 G5030 S 1382094 0 +29.3740192 -100.9258136
950302 2 484659503022 Block Group 2 G5030 S 3683955 53212 +29.3634330 -100.9287735
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950700 5 484659507005 Block Group 5 G5030 S 11529535 397616 +29.3381154 -100.9222337
950302 1 484659503021 Block Group 1 G5030 S 1814482 1915 +29.3617914 -100.9136547
(0 out of 34 Selected)
tl_2010_48465_bg10
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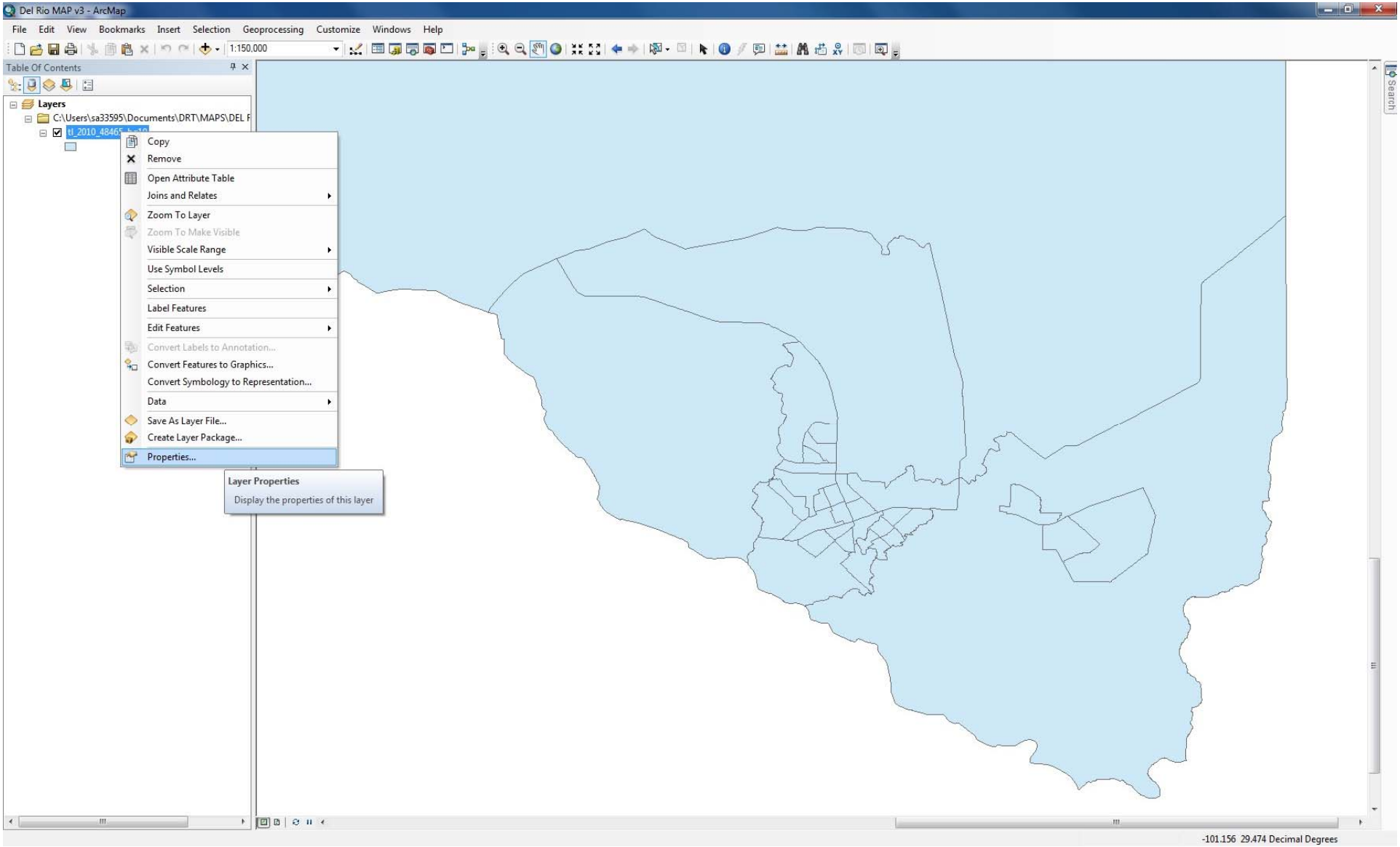
tl_2010_48465_bg10
Search
-100.808 29.526 Decimal Degrees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1:150,000
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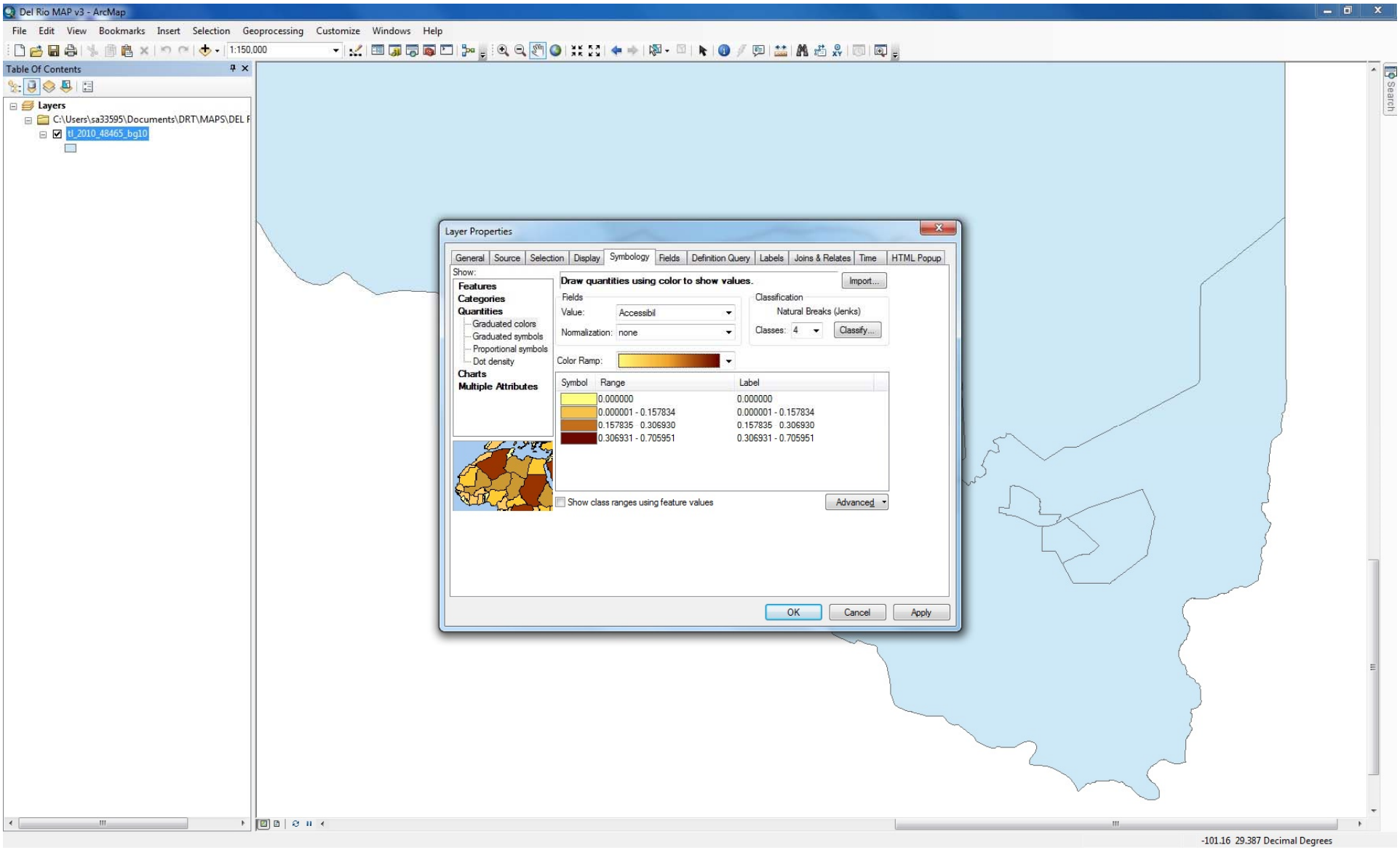
Copy
Remove
Open Attribute Table
Joins and Relates
Zoom To Layer
Zoom To Make Visible
Visible Scale Range
Use Symbol Levels
Selection
Label Features
Edit Features
Convert Labels to Annotation...
Convert Features to Graphics...
Convert Symbology to Representation...
Data
Save As Layer File...
Create Layer Package...
Properties...
Layer Properties
Display the properties of this layer
Search
-101.156 29.474 Decimal Degrees


Del Rio MAP v3 - ArcMap
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1:150,000
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tl_2010_48465_bg10
Layer Properties
General Source Selection Display Symbology Fields Definition Query Labels Joins & Relates Time HTML Popup
Show:
Features
Categories
Quantities
Graduated colors
Graduated symbols
Proportional symbols
Dot density
Charts
Multiple Attributes
Draw quantities using color to show values.
Import...
Fields
Value: Accessibil
Normalization: none
Classification
Natural Breaks (Jenks)
Classes: 4
Classify...
Color Ramp:
Symbol Range Label
0.000000 0.000000
0.000001 - 0.157834 0.000001 - 0.157834
0.157835 0.306930 0.157835 0.306930
0.306931 - 0.705951 0.306931 - 0.705951
Show class ranges using feature values
Advanced
OK
Cancel
Apply
Search
-101.16 29.387 Decimal Degrees

Questions?

sastroza@utexas.edu

Category	DRT Agency	Category Characterization	
		Main characteristics	Secondary characteristics
Small areas	Cleburne, City of; CCART; Fort Bend County Rural Transit District; SCRPT; SPAN; The Transit System, Inc.; Galveston County Transit District.	-Area served < 1,000 sq. miles	-Buses are more common than for other typology categories
		-Full coverage in most urban areas	-Young fleet (less than 6 years on average)
		-Flexible route type in most areas	-Small fleet (less than 30 vehicles on average)
Medium areas	GCRPC; Kleberg County Human Services; Public Transit Services; RPMC; REAL.	-Area served between 1,000 and 8,000 sq. miles	-Relatively late (8am) opening time
		-Full coverage in most urban areas	-No service during weekends in most areas
		-Flexible route type and route deviation	-Small vehicle capacity (12 seats per vehicle on average)
Large areas	AACOG; Brazos Transit District; Central Texas Rural Transit District; Hill Country Transit District; PCS; SPCAA; Southwest Area Regional Transit District; WTO.	-Area served > 8,000 sq. miles	-No service on Sundays, some agencies operate on Saturdays
		-Flexible route type in most areas	-Large fleet (more than 85 vehicles on average)
Rural areas	CARTS; Concho Valley Transit District; Del Rio, City of; ETCOG; STAR Transit; Texoma Area Paratransit System, Inc..	-Within rural areas only	-Some agencies offer partial urban coverage for medical purposes only
		-Limited medical services provided	-Old fleet (more than 7.5 years on average)
		-Operates a fixed route (non DRT) service	
		-Door-to-door service available in some areas	
		-Variable days and hours of operation	
Non-medicaid	ATCOG; BCAA; Colorado Valley Transit; CACST; Gulf Coast Center; HOTCOG; Lower Rio Grande Valley Development Council; SETRPC; Webb County Community Action Agency;	-No service for medicaid appointments	-Partial coverage in most urban areas
		-Flexible route type or route deviation	-No service on Sundays, some agencies operate on Saturdays
		-Door-to-door service not available in most areas	-Buses are not common