Analysis of Change in Land Use around Future Core Transit Corridors: Austin, TX, 1990-2006

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May 3, 2012

PROBLEM DEFINITION

This study examines the change in land use from 1990 to 2006 in the City of Austin (COA)'s future core transit corridors. The study tries to discover if certain land use changes caused these areas to be developed into future core transit corridors. Land use analysis will focus on single and multi- family housing in previously undeveloped land; but other important land use categories will also be investigated. The land within a half mile radius of the actual roadway was examined. A half mile is the maximum reasonable length at which a mobile population could be expected to walk for access to transit.

DATA

All of the data for this study was downloaded from the City of Austin's GIs data set page. The core transit corridors data and the land use data sets for 1990, 2003, and 2006 were downloaded. The data files and metadata can be found at ftp://ftp.ci.austin.tx.us/GIS-Data/Regional/coa_gis.html.

Before proceeding in this study, a few key terms must be defined for use in this study. The definition of a "core transit corridor" is very abstract; contacted COA staff could not provide a succinct definition to the term. Based upon the Design Policy standards document and supporting literature, a "core transit corridor" is one type of roadway in a set of five, the others including: internal circulation route, urban roadway, suburban roadway, and highway roadway. The core transit corridor is the highest priority roadway type for sidewalk, building placement, and streetscape standards. The COA Design Standards document sets of minimum of 15-foot wide sidewalk along core transit corridors, of which 7 feet must be clear space (free of sidewalk furniture or landscaping). Strict building standards, parking regulations, and access to affordable housing also apply to core transit corridors. The study will attempt to find commuter relationship amongst these types of roadway corridors. A map of the current and future core transit corridors for the Austin area can be seen on the next page.

Data quality is somewhat questionable for all of the COA's GIS data sets. The 1990 data is much less detailed than the 2003 and 2006 data (e.g. single family plots aggregated in larger areas). The future land use data set was determined to have too many gaps in data to include in the study. The provided metadata has a section for reliability of the data and problems remaining, but the section is left blank.

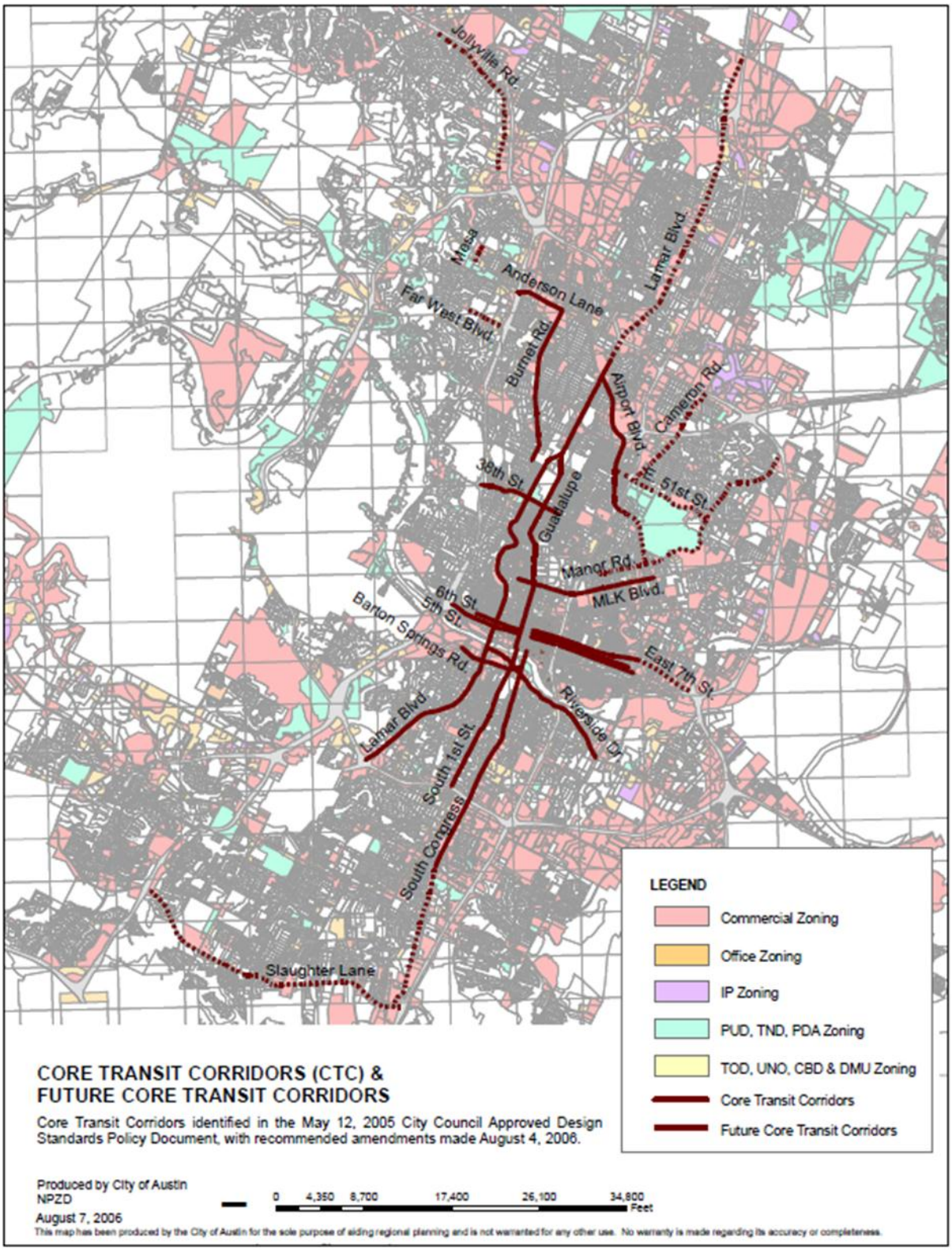


Figure 1. Core Transit Corridors, City of Austin. Dashed lines are future core transit corridors Subchapter E: Designs Standards and Mixed Use. 2006. City of Austin.

STUDY PROCEDURE

A. Download Necessary Data Sets for City of Austin GIS Site

A list of the shapefiles from the Austin GIS website used in this study is listed below:

- 1990 Land Use Map
- 2003 Land Use Map
- 2006 Land Use Map
- Core Transit Corridors

The attributes for the land use data contain codes corresponding to certain land use types. The key for the codes is available in the metadata for any of the land use data sets on the same site. The procedure for joining the description to the codes will be detailed later.

B. Change the Coordinate System of the Data

Using ArcCatalog, make sure that all data uses the NAD 1983 StatePlane Texas Central FIPS_4203 coordinate system. US feet will be the unit of measure.

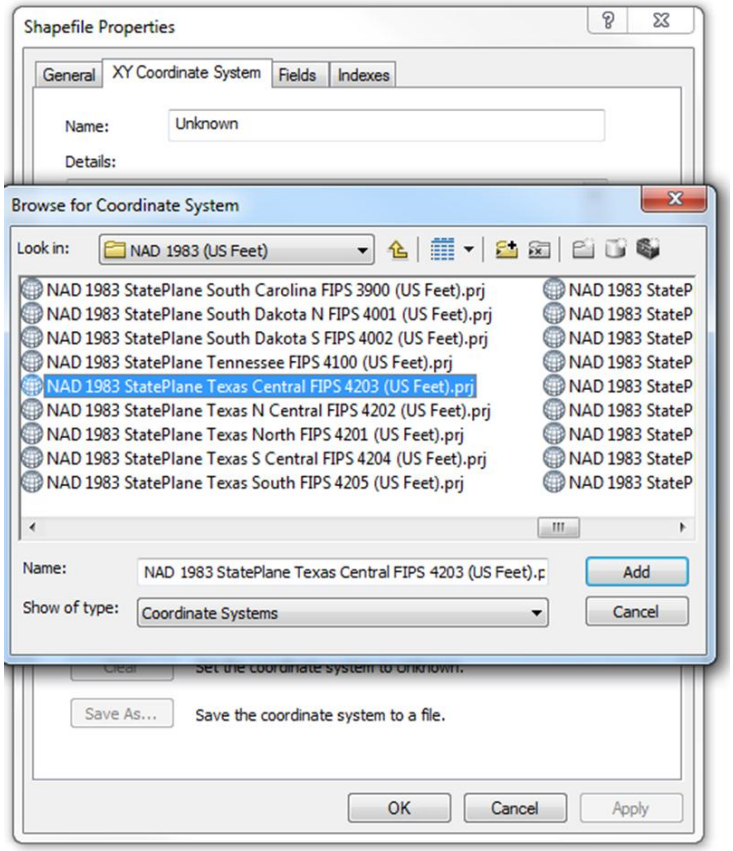


Figure 2. Set Spatial Reference to NAD 83 Texas Central FIPS 4203

C. Create New Shapefiles Comprising only Future Core Transit Corridors

Load the Core Transit Corridors into a new ArcGIS map.

Highlight a segment of the corridor map that corresponds to a Future Core Transit Corridor. See map in Figure 1 for what constitutes a future transit corridor. Make the Core Transit Corridor layer selectable and draw a rectangle around the appropriate region.

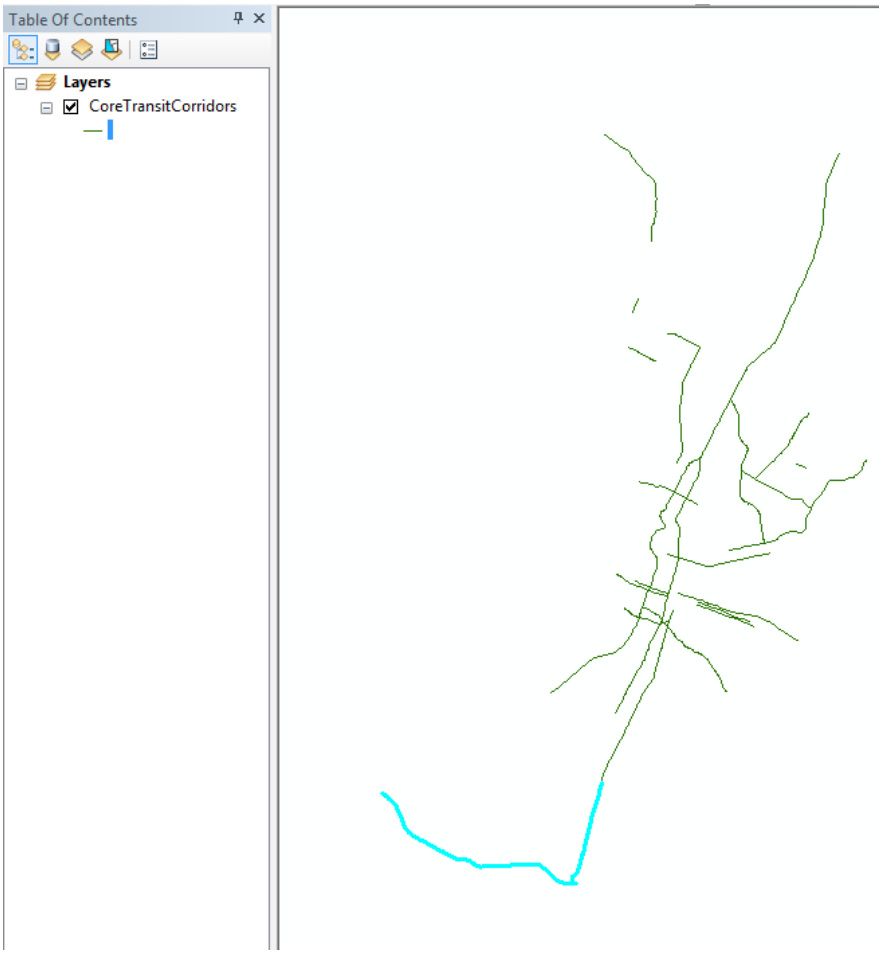


Figure 3. Selection of the South Congress/ Slaughter core transit corridor

Export these selected features to a new shapefile. Right-click on the Core Transit Corridors layer in the Table of Contents and choose Data…|Export Data…

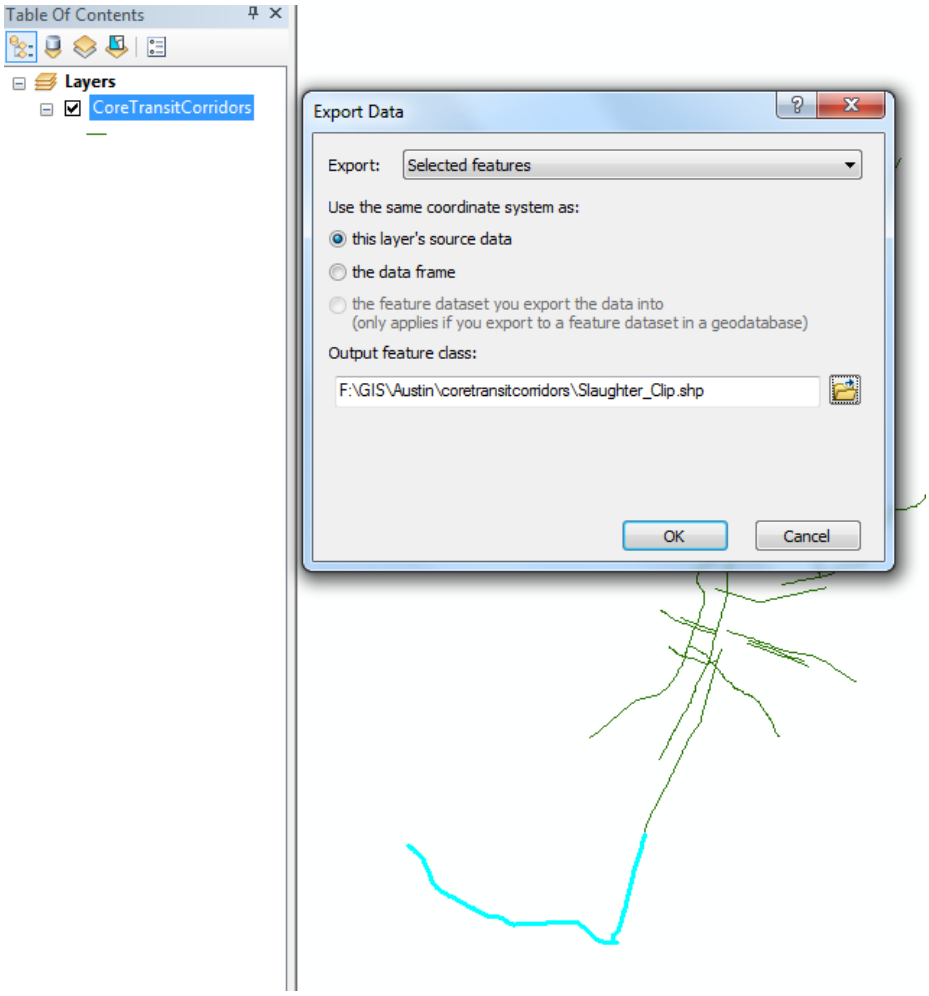


Figure 4. Export the selected features to a new shapefile

Repeat the highlighting and exporting steps for the four remaining future core transit corridors.

D. Create Corridor Regions for Study

The study is interested in land use changes over time in future transit corridors. It is important to define the area for which each corridor will be studied. In transportation planning, it is a general rule of thumb at 90% of a typical population will travel at most a quarter of mile for public transportation. However, for younger and more mobile cities such as Portland or Austin, a good share of people is willing to travel up to a half mile for access to public transport. A half-mile buffer will be set up for each of the future core transit corridors to examine land use change over time for areas with reasonable pedestrian access to the corridor.

Use the Buffer tool under the Geoprocessing tab in ArcMap or within ArcToolbox. Select one of the newly created future core transit corridor feature classes as the input feature. Appropriately name the new buffer feature class. Set the linear unit to 2640 feet (1/2 mile). Set the round type

to round and be sure to dissolve ALL. Repeat this procedure for the four remaining future core transit corridors. See Figure 5 for proper settings.

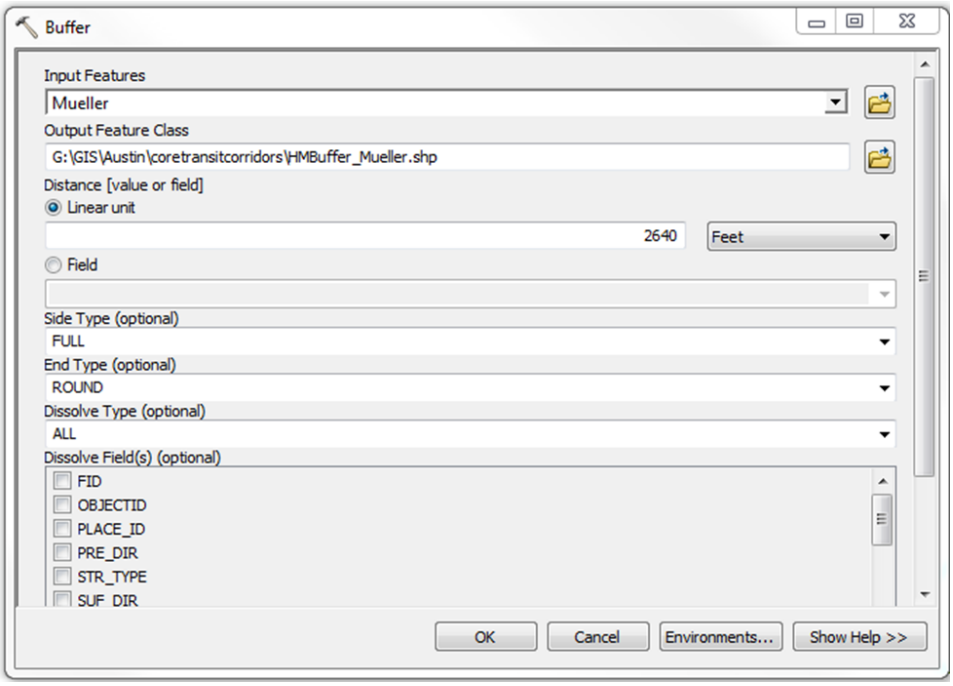


Figure 5. Buffer tool under the Geoprocessing tab in ArcMap. Available in ArcToolbox.

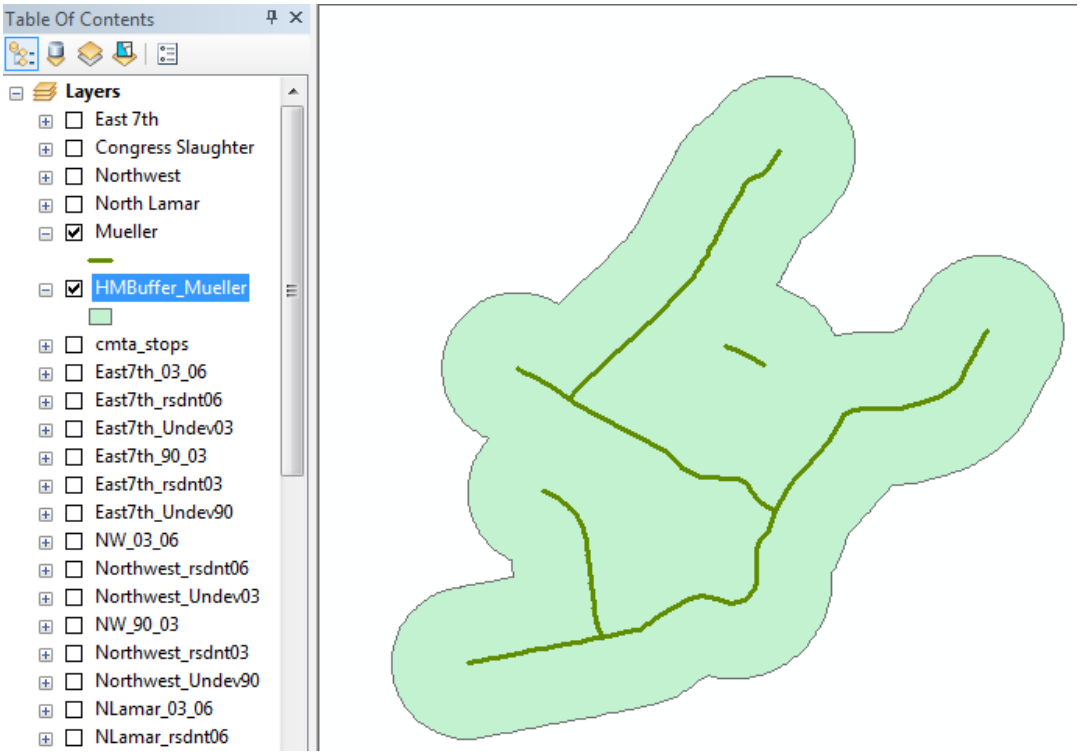


Figure 6. Half Mile Buffer of the Mueller Corridors

E. Clip Austin Area Land Use Data Sets to Future Core Transit Corridors

The land use data sets for the city of Austin are very large. The data must be clipped to the specific future core transit corridor region to make the file size more manageable and speed up the time to load the file. Use the Clip tool under the Geoprocessing tab in ArcMap or within ArcToolbox.

Choose one of the land use data sets as the input feature. Choose one of the future core transit corridor regions as the clip feature. Give the output feature class an appropriate name and add the new feature class to the ArcGIS project. Repeat this procedure for the two other land use data sets for this region.

Repeat the above procedure for the four other core transit corridor regions in the study.

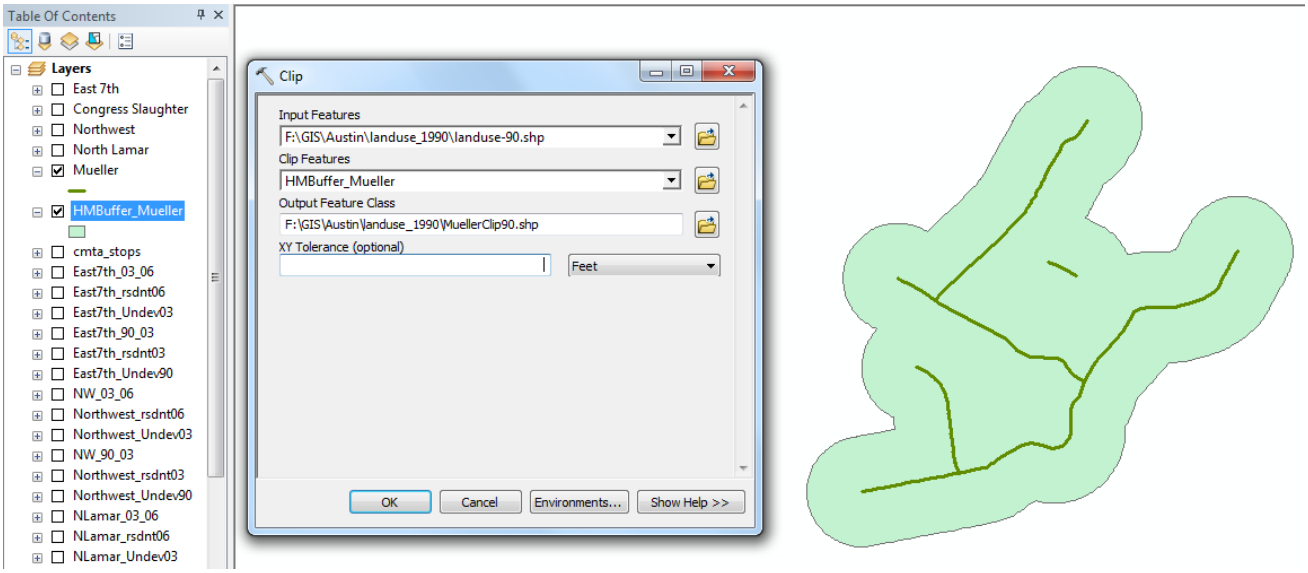


Figure 7. Clip Land Use Data to the Future Core Transit Corridor (Mueller Region above)

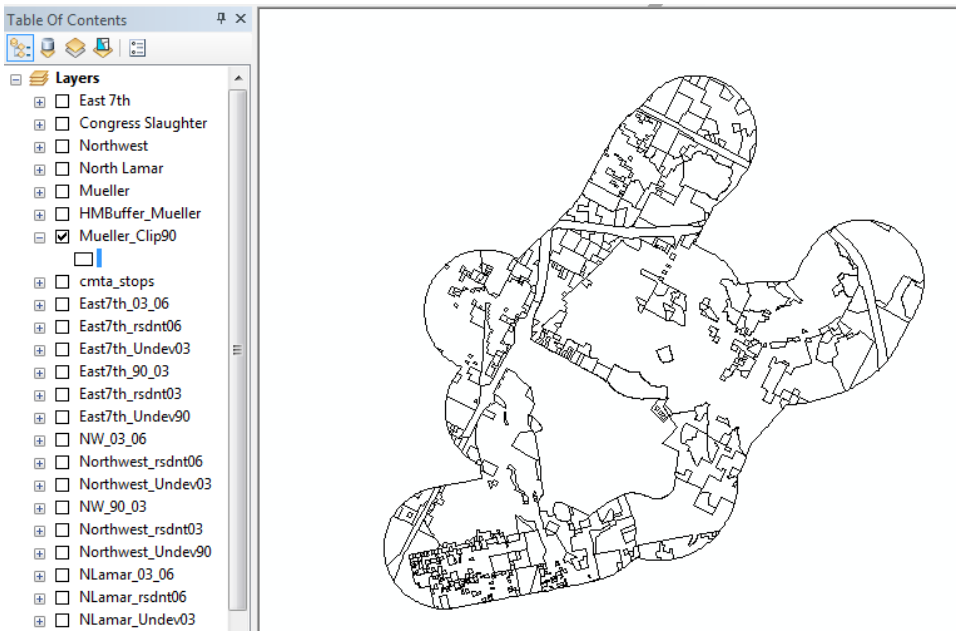


Figure 8. Clip Land Use Data to Buffer Region (1990 Land Use Data in Mueller Corridors)

The areas of the land use must be recalculated after the clip has been performed. Right click on one of the clipped land use shapefiles and select Open Attribute Data. If the data is part of the 1990 set, right click on Area (Shape_Area for the 2006 data). 2003 needs a new column for area and will be discussed later. Select Calculate Geometry. The property should default to Area and the correct coordinate system. See Figure 9 below.

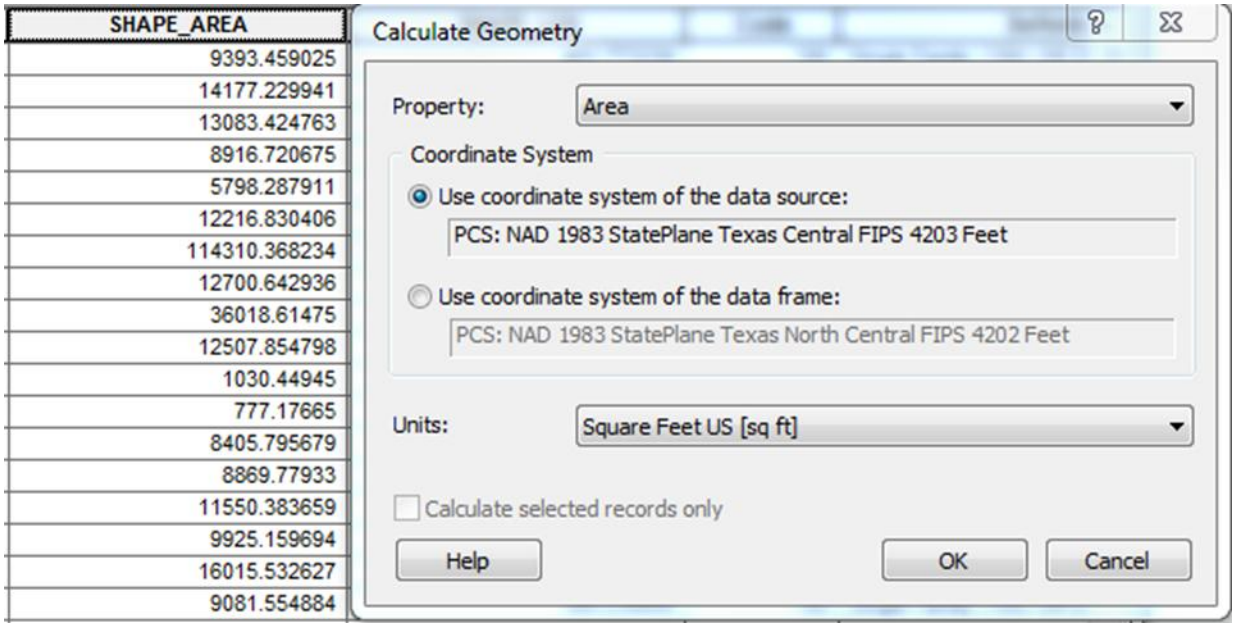


Figure 9. Calculate the clipped areas of the land use data for a 2006 data set.

2003 data requires the addition of a new field for area. With the attribute table open, click on Table Options and select Add field. Name the field Area. Right click on the newly created field and select Calculate Geometry. The property should default to Area and the correct coordinate system. See Figure 9 above.

F. Join Metadata to the Land Use Codes in the Attribute Data

The land use data only provides a code for the type of land use that each polygon in the region represents. Metadata from the COA site must be joined to the codes in the attribute data to define the type of land use. Copy the table in the metadata for the 1990, 2003, or 2006 table describing the land use codes into Excel. Any year is fine; the codes are the same. Save the Excel file as a comma-delimited file (.csv).

Right click on one of the clipped land use layers. Select Table Options| Join… Select the field from the attribute table that contains the proper land use code, either GeneralLA or LUCODE. Choose the csv file that contains the definitions of the codes. Join based upon the code field in the .csv file. See Figure 10 below for the proper settings.

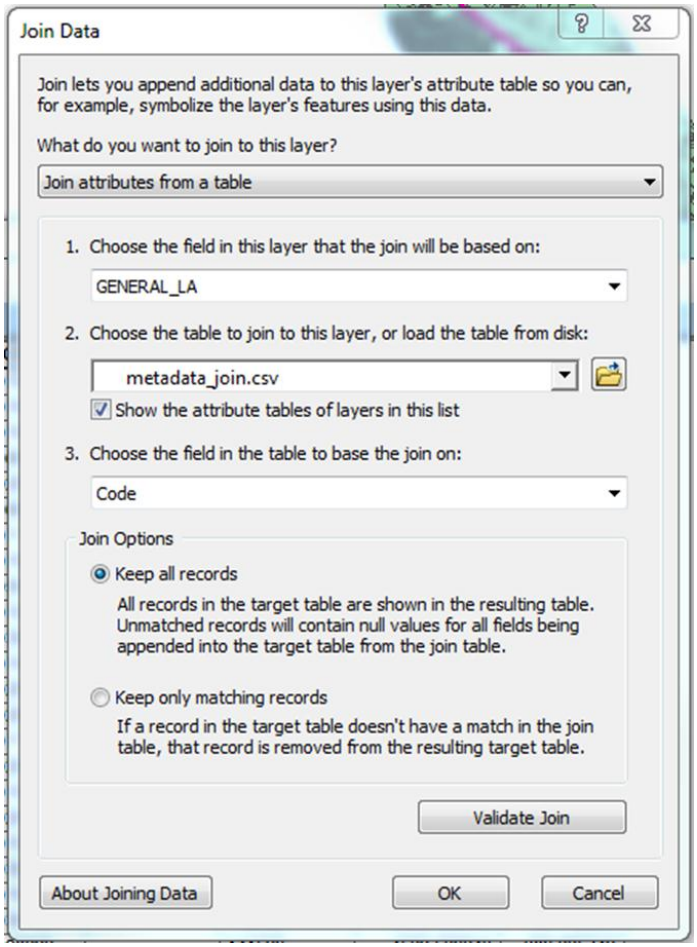


Figure 10. Join data from metadata .csv file to the attribute table

Repeat the join for every one of the fifteen clipped land use regions.

G. Create Map Showing Land Use Over Time

This study is primarily interested in determining how much undeveloped land is converted into single family or multi-family land use. The visually display how much land is transformed from undeveloped to residential housing, the Intersect tool must be used.

To use the intersect tool, new shapefiles must be created for the undeveloped land in the earlier period and the single family or multi-family housing in the later period. Use the Select by Attribute tool under the Selection tab for this.

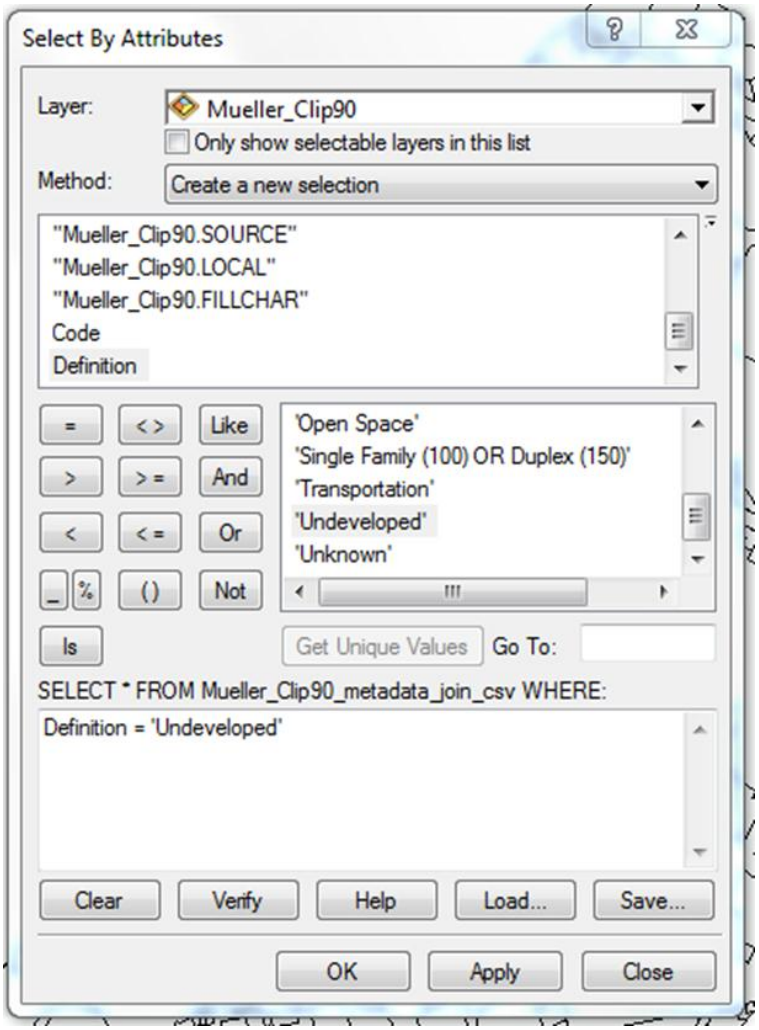


Figure 11. Select Undeveloped Land from the Earlier Data Set

Right click on the Selected Data Layer and click Data…|Export Data. Export the selected data to a new shapefile and add to the ArcGIS project. Give the output feature class an appropriate name. See Figure 11 above for help.

Follow the same process for 1990 and 2003 undeveloped land, and 2003 and 2006 single family and multi-family land use for every one of the five future core transit corridor regions.

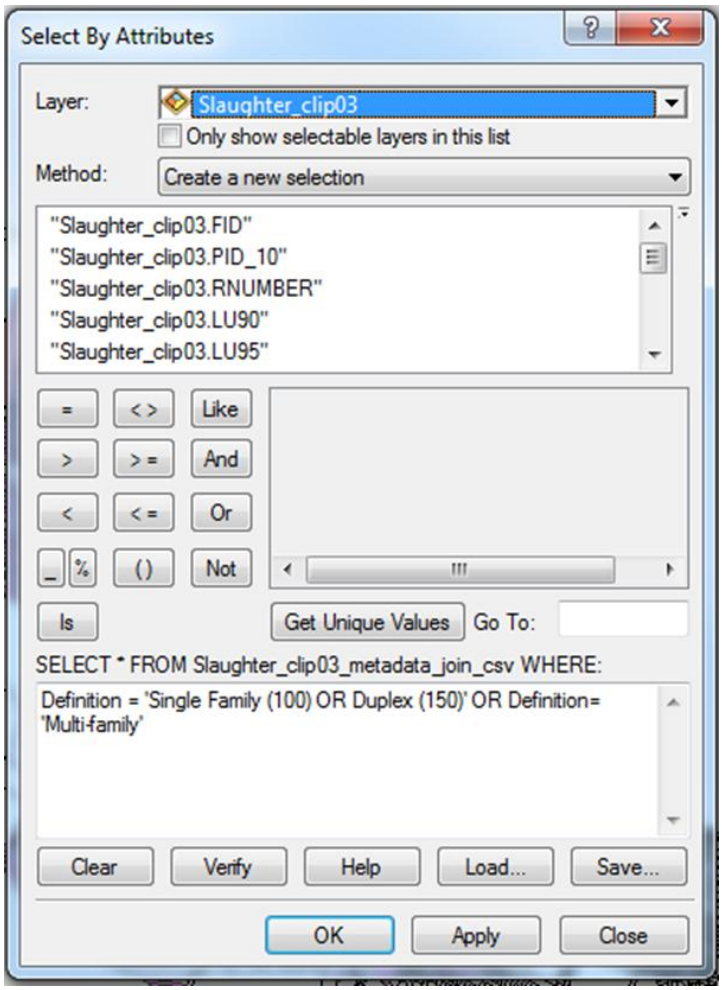


Figure 12. Select the Single Family and Multi-Family Data from the Later Period

Now that all of the new layers are created, the intersections can now be performed. Choose the Intersect tool from the Geoprocessing tab in ArcMap or from within ArcToolbox. Choose a feature class containing the data from undeveloped land with a future core transit corridor region. Choose the corresponding feature class with the data for single-family and multi-family housing in the later period. Choose an appropriate name for the output feature class and add to the ArcGIS project. See Figure 13 below for the correct settings in the Intersect tool.

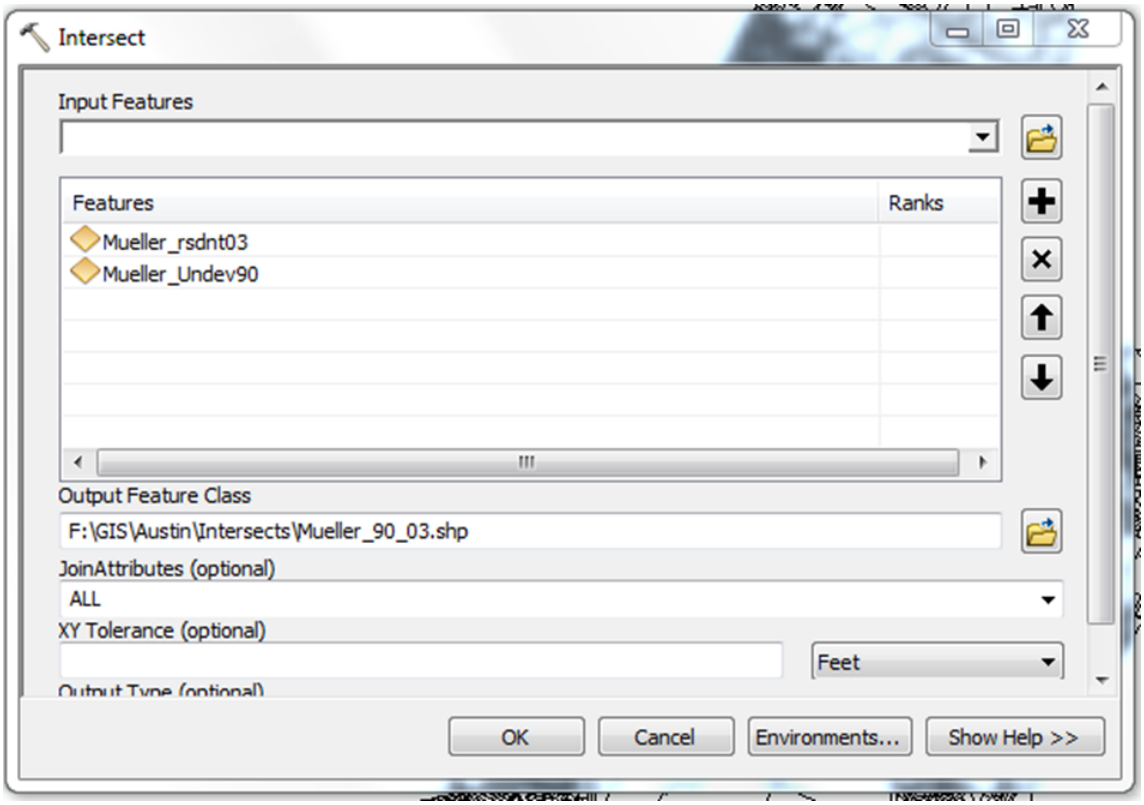


Figure 13. Creating an intersection for land use change in the Mueller Corridors (90-03)

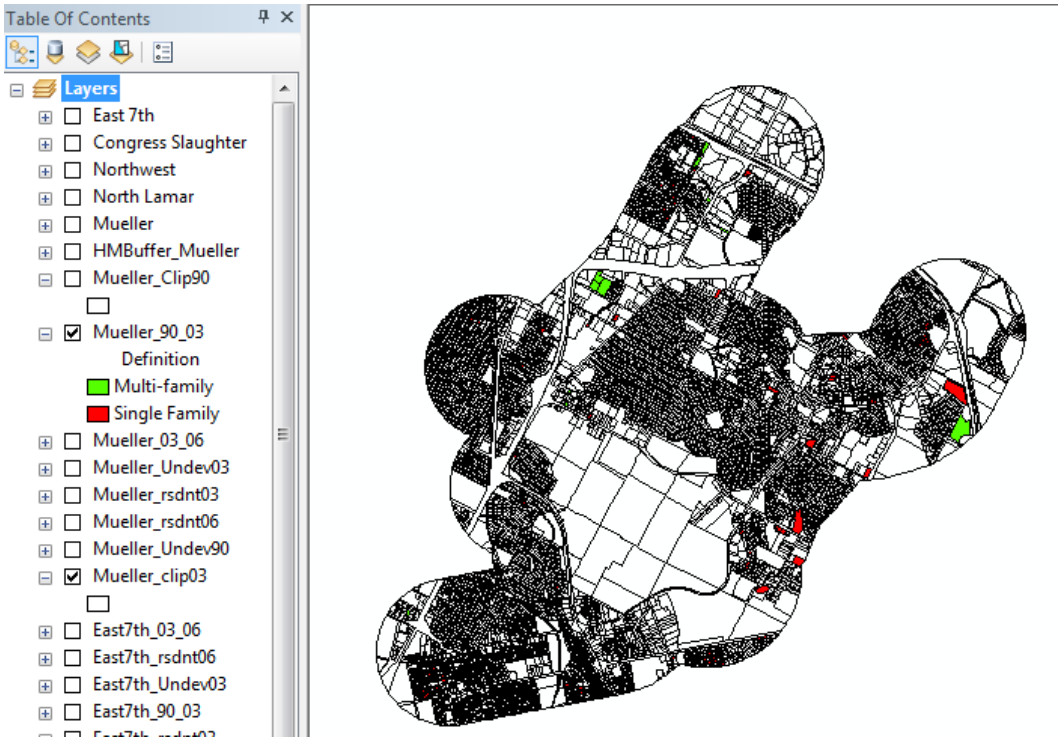


Figure 14. Example Intersected Data (Mueller Corridors, 1990 to 2003)

Repeat this intersection process for the nine remaining pair of undeveloped land and single/multi-family housing land use. Intersections should look like Figure 14 above.

The areas of the polygon data must be updated for each of the ten newly created intersected shapefiles. See Section E for how to update the areas. Change the symbology of the intersection feature classes. Give the land turned into single-family housing a bright color and the land converted into multi-family another bright color, distinguishable from the single-family housing.

H. Transfer into Excel and Process Data

1. Areas Converted into Single Family or Multi-Family Land Use

Open the attribute table for one of the intersected data feature classes. Sort the data based upon the Definition field. Select all of the records defined as multi-family. Right click on the Area field and select statistics. Copy and paste the sum into Excel. Repeat the process for records defined as single family.

Repeat for the nine remaining intersected feature classes.

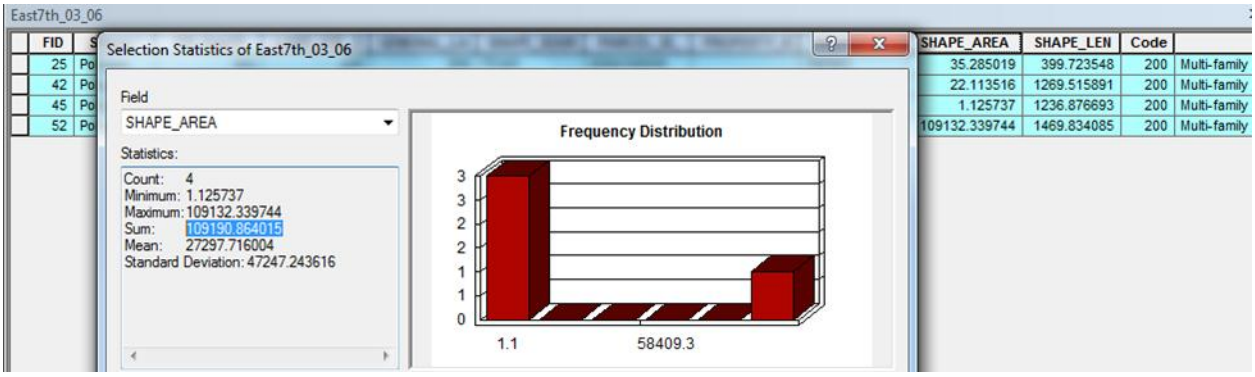


Figure 15. Statistics for Multi-Family Land Use Zones Created from Undeveloped (03-06, East 7th corridor)

The resulting excel table should look like this. Obtaining the area of undeveloped land will be described in the following section.

		Slaughter		Northwest		North Lamar		Mueller		East 7th	
			Percent		*Percent*		*Percent*		*Percent*		*Percent*
1990	*Undeveloped*	134551807.3		39200681		63211117.82		37321259		8220951	
2003	*Single Family*	20585967.7	15.30%	4381392.9	11.18%	4791288.85	7.58%	2905323	7.78%	1320312	16.06%
	Multi-Family	7279820.146	5.41%	9052611.3	23.09%	4994535.925	7.90%	1209049	3.24%	18270.13	0.22%
2003	*Undeveloped*	79975120.68		7923085.4		27754548.71		45108162		3579598	
2006	*Single Family*	4143845.997	5.18%	19844.939	0.25%	189530.1807	0.68%	998007.2	2.21%	407821.7	11.39%
	Multi-Family	3358341.305	4.20%	36962.845	0.47%	117065.2712	0.42%	22474.03	0.05%	109190.9	3.05%

Figure 16. Data for Land Changes Over Time

2. *Areas for More Land Use Types*

Land use dedicated to civic, commercial, industrial, open space, offices, and transportation is also of interest in the future core transit corridor regions. To process this data, the fifteen clipped land use feature classes will be used, not the ten intersected feature classes.

Right click on one of the fifteen land use data layers in the TOC. Open the Attribute table and Export the Data to a textfile. Give the textfile an appropriate name. See Figure 17 below for the proper settings. Repeat this procedure for the remaining fourteen feature classes.

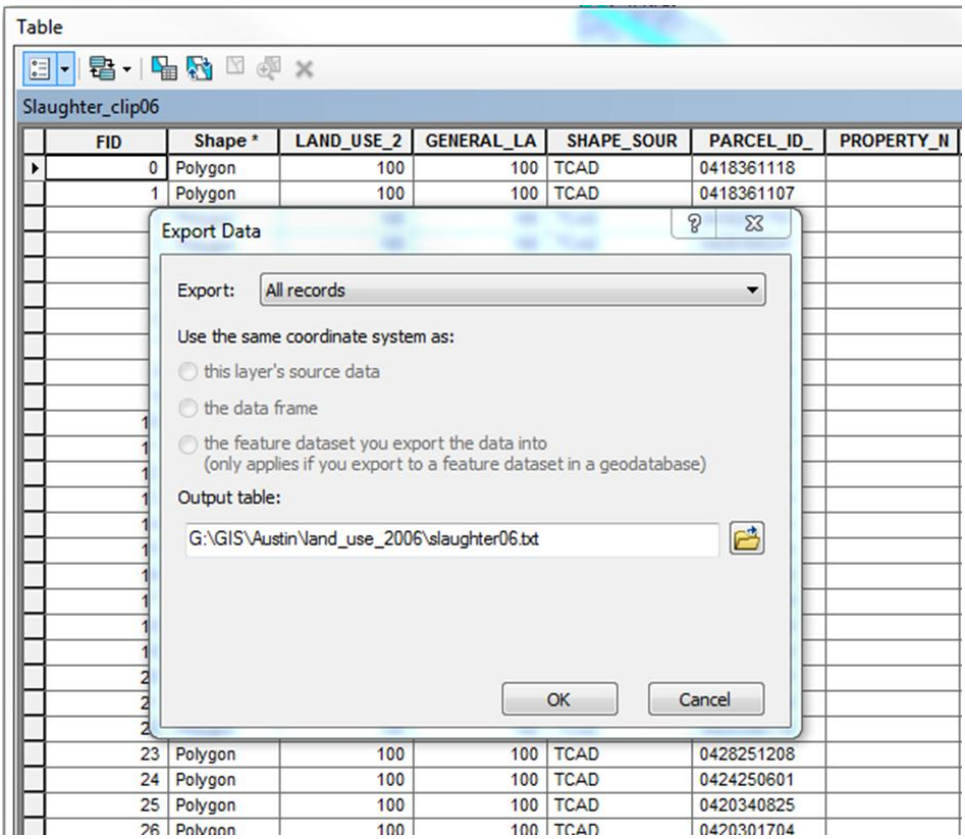


Figure 17. Exporting Data to the Textfile

Open each of the textfiles in Excel. Use the wizard to properly convert the textfile into an Excel spreadsheet; the data will be comma delimited. Combine all fifteen excel sheets into one workbook for convenience.

Highlight all of the data in one of the fifteen worksheets and select Create PivotTable from the Insert ribbon. See Figure 18 for a view of this window.

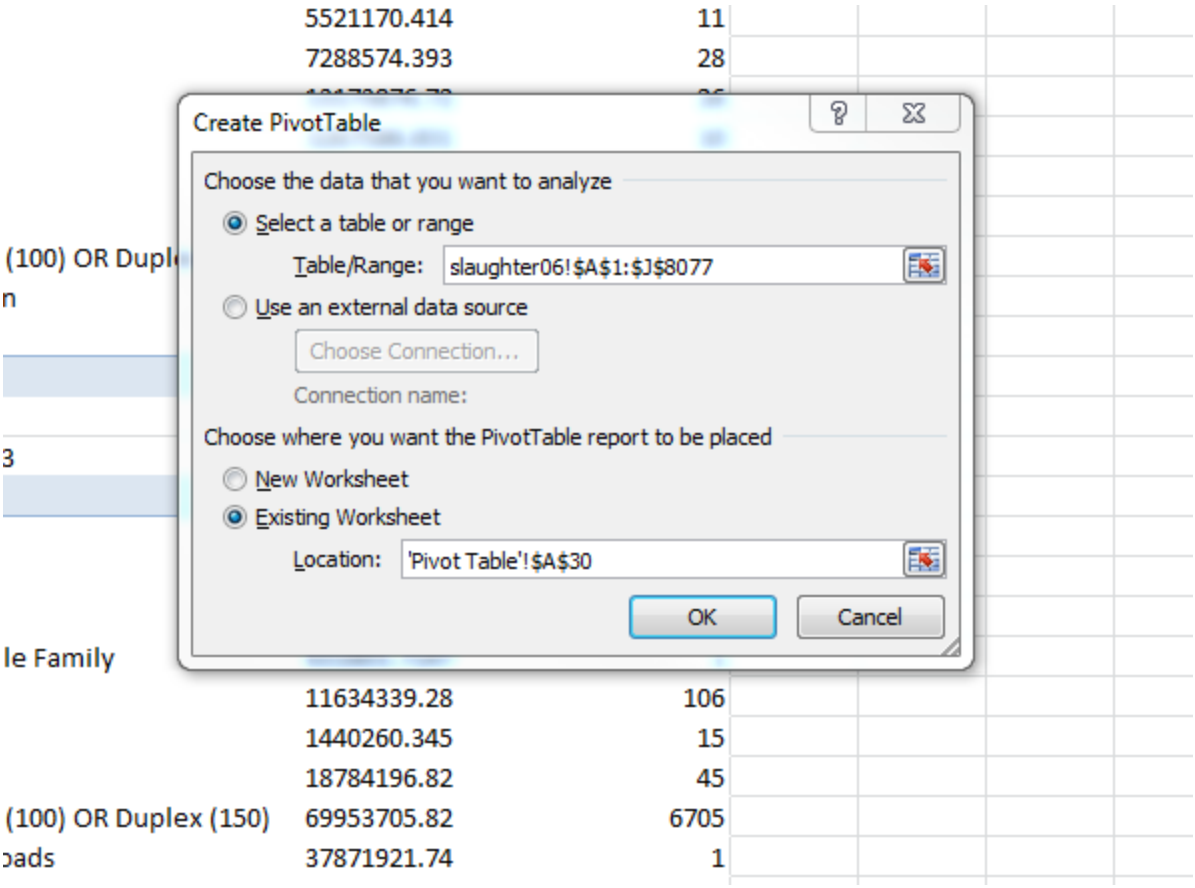


Figure 18. Creating a New PivotTable in Excel

Place the pivot table in a new worksheet titled ‘Pivot Table’. Set the Pivot table settings exact to those shown in Figure 19 below. Some of the field names may vary slightly across each of the different years. A sample of a final pivot table can be seen in Figure 20. The definition of the land use type will be the road label, while the sum of areas and the count of the rows in each category will be column values. Adjust the row labels as necessary in the pivot table by using the drop-down menu next to the row label title (large-lot single family would not be important to the data analysis).

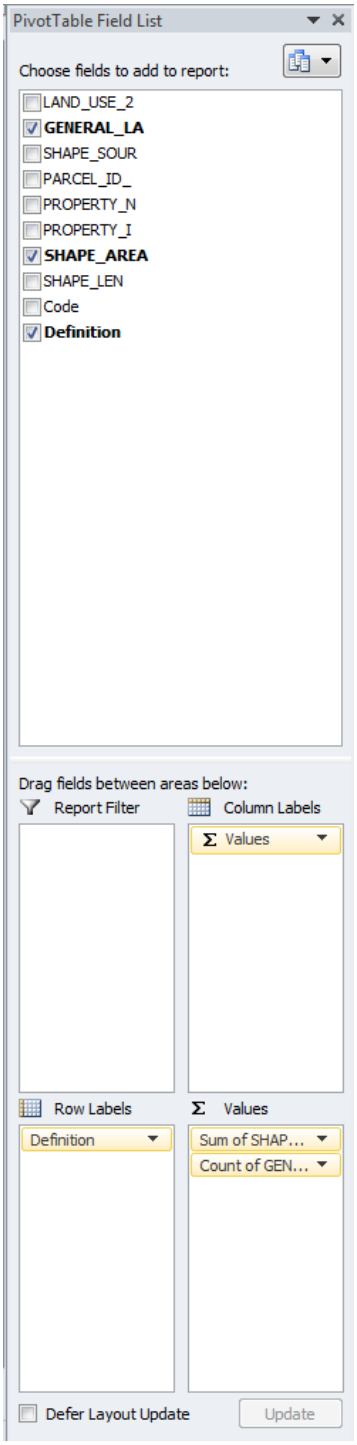


Figure 19. Settings for an Individual Pivot Table for Data Analysis in Excel

Slaughter 2006		
Row Labels	**Sum of SHAPE_AREA**	**Count of GENERAL_LA**
Civic	9379269.167	42
Commercial	20931027.96	171
Industrial	4475344.261	41
Large-lot Single Family	2827985.325	2
Multi-family	15457772.62	105
Office	2113209.268	28
Open Space	21714970.44	89
Single Family (100) OR Duplex (150)	73254171.77	7106
Streets and Roads	38120254.5	47
Transportation	1069656.82	5
Undeveloped	57933225.59	359
Grand Total	**247276887.7**	**7995**

Figure 20. Sample Pivot Table (Slaughter Corridor, 2006 data)

RESULTS

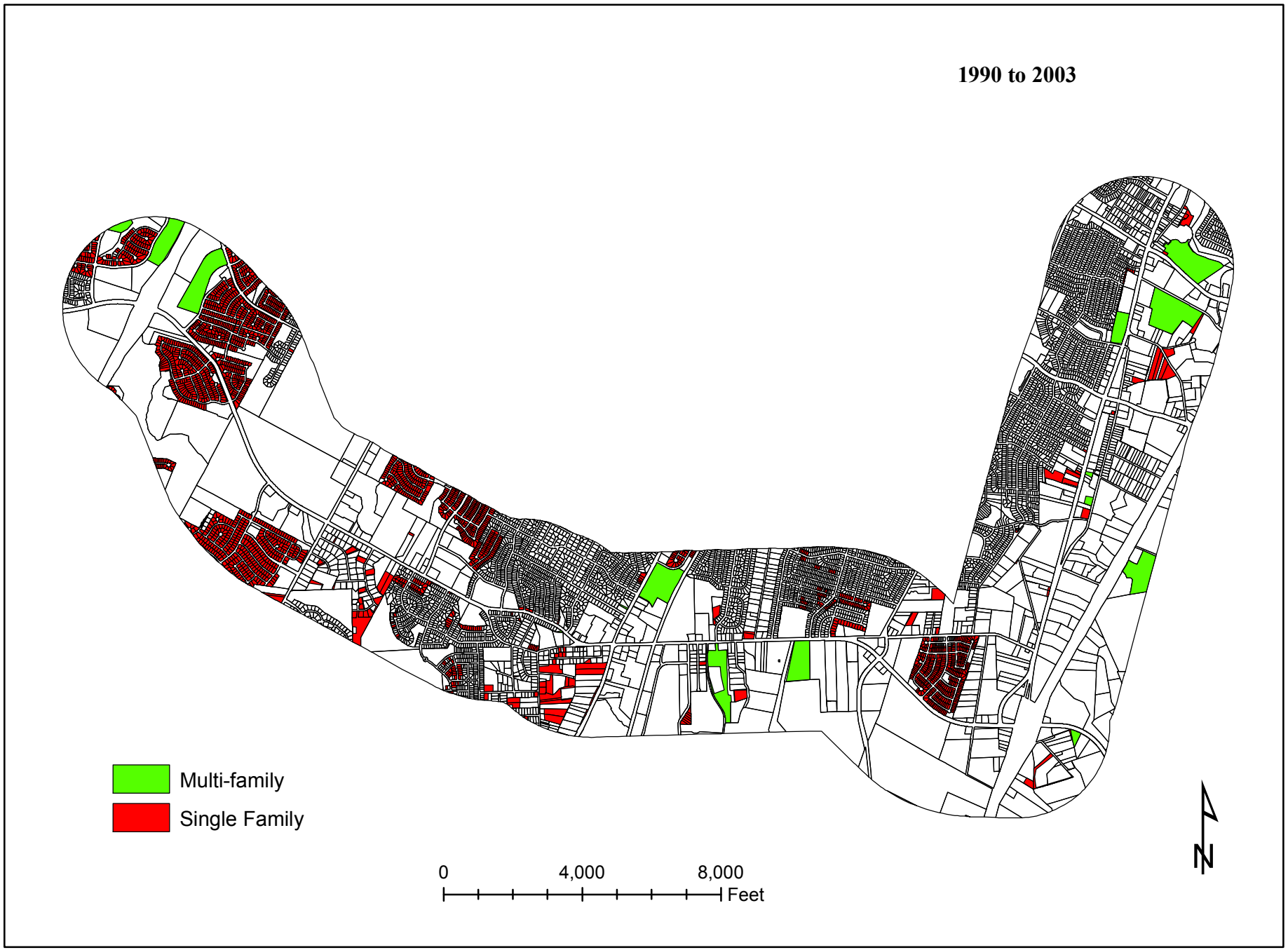
The primary objective of this GIS study was to examine how much undeveloped land was converted to single-family or multi-family housing in future core transit corridor regions. Changes were studied for the period from 1990 to 2003 to see if significant changes led to designating these areas as future core transit corridors. The period from 2003 to 2006 was also studied to see if the action of designating the corridors as such resulted in greater changes in land use. Table 1 below shows the results for each of the five corridor regions.

Table 1. Changes in Land Use for Undeveloped Regions (1990-2003 and 2003-2006)

		Slaughter		**Northwest**		**North Lamar**		**Mueller**		**East 7th**	
		Area(sq ft)	*% Change*	*Area(sq ft)*	*% Change*	*Area(sq ft)*	*% Change*	*Area(sq ft)*	*% Change*	*Area(sq ft)*	*% Change*
1990	*Undeveloped*	134551807		39200681		63211118		37321259		8220951	
2003	*Single Family*	20585968	15.30%	4381393	11.18%	4791289	7.58%	2905323	7.78%	1320312	16.06%
	Multi-Family	7279820	5.41%	9052611	23.09%	4994536	7.90%	1209049	3.24%	18270	0.22%
2003	*Undeveloped*	79975121		7923085		27754549		45108162		3579598	
2006	*Single Family*	4143846	5.18%	19845	0.25%	189530	0.68%	998007	2.21%	407822	11.39%
	Multi-Family	3358341	4.20%	36963	0.47%	117065	0.42%	22474	0.05%	109191	3.05%

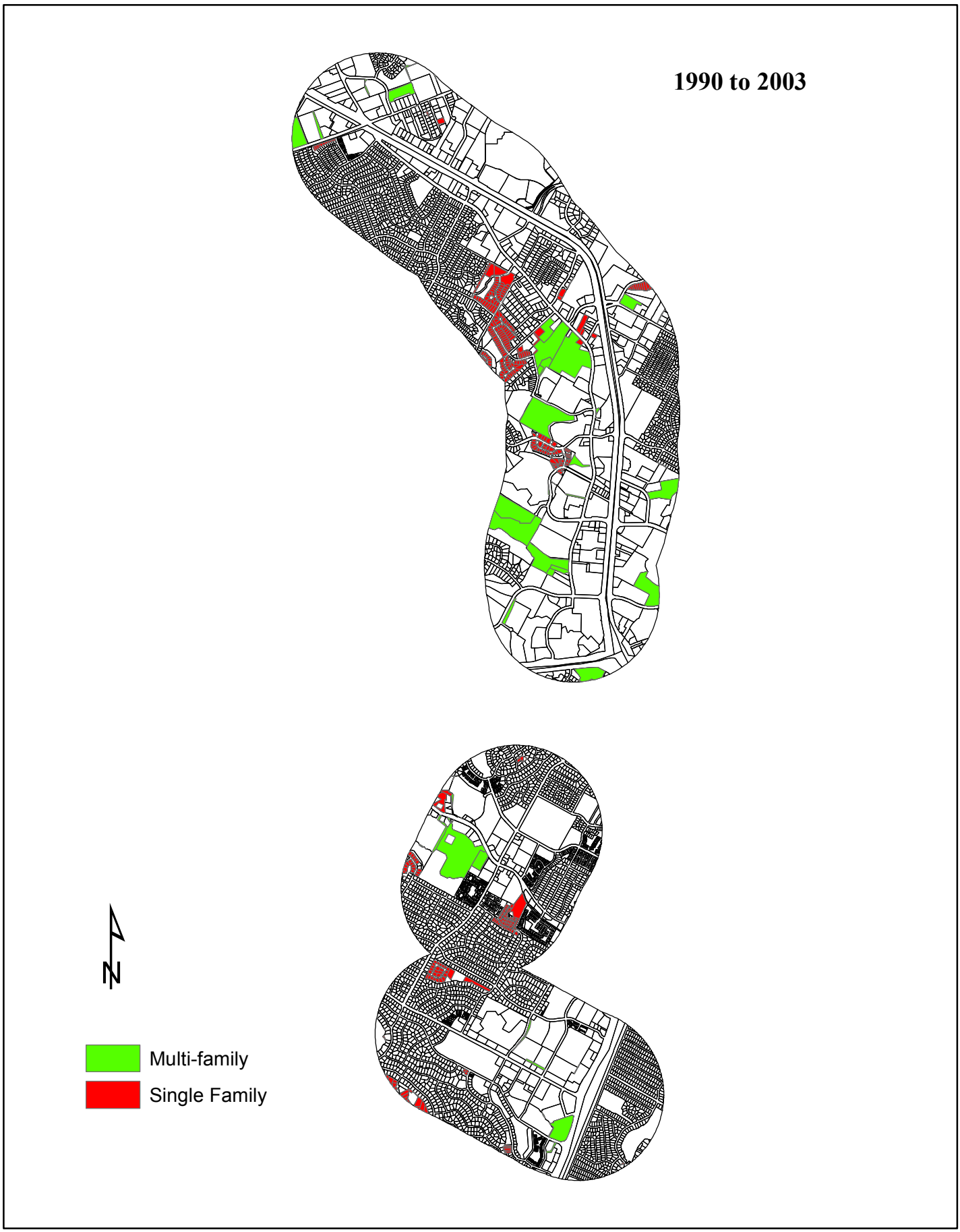
Several areas seem to have substantial changes in land use across these periods. The Slaughter-South Congress corridor experiences significant change in undeveloped land use from 2003-06 especially relative to the change from 2003-2006. The East 7th future corridor also saw great change in undeveloped land being converted from undeveloped land to single family land use from 2003-06. Undeveloped land was developed fairly aggressively from 1990-2003 but slowed in the 2003-2006 time period. The following maps visually display the development of single and multi-family housing from previously undeveloped land.

Undeveloped Land to Single or Multi-Family Housing: Slaughter/ South Congress Corridor



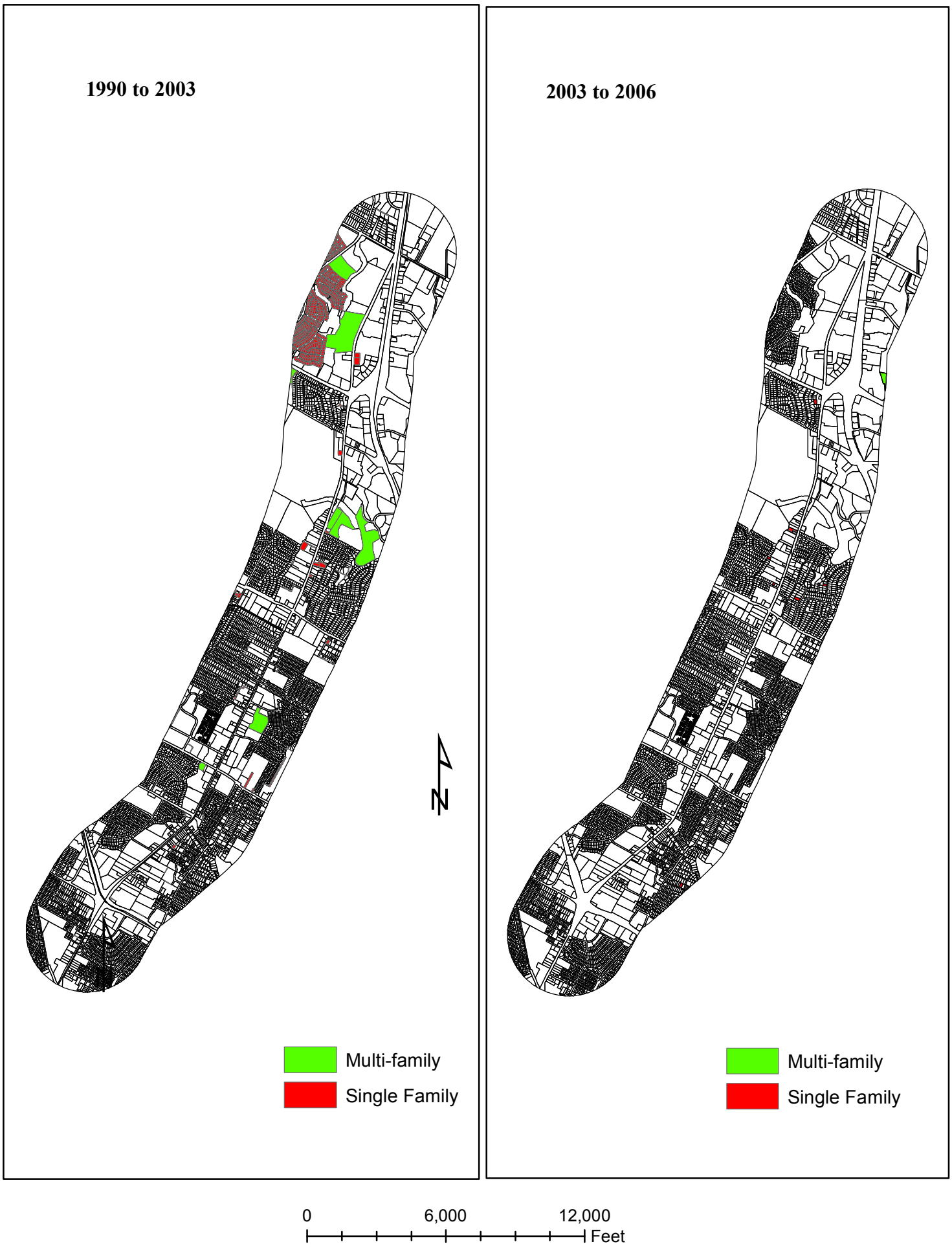
Undeveloped Land to Single or Multi-Family Housing: Slaughter/ South Congress Corridor

Undeveloped Land to Single or Multi-Family Housing: Northwest Corridor



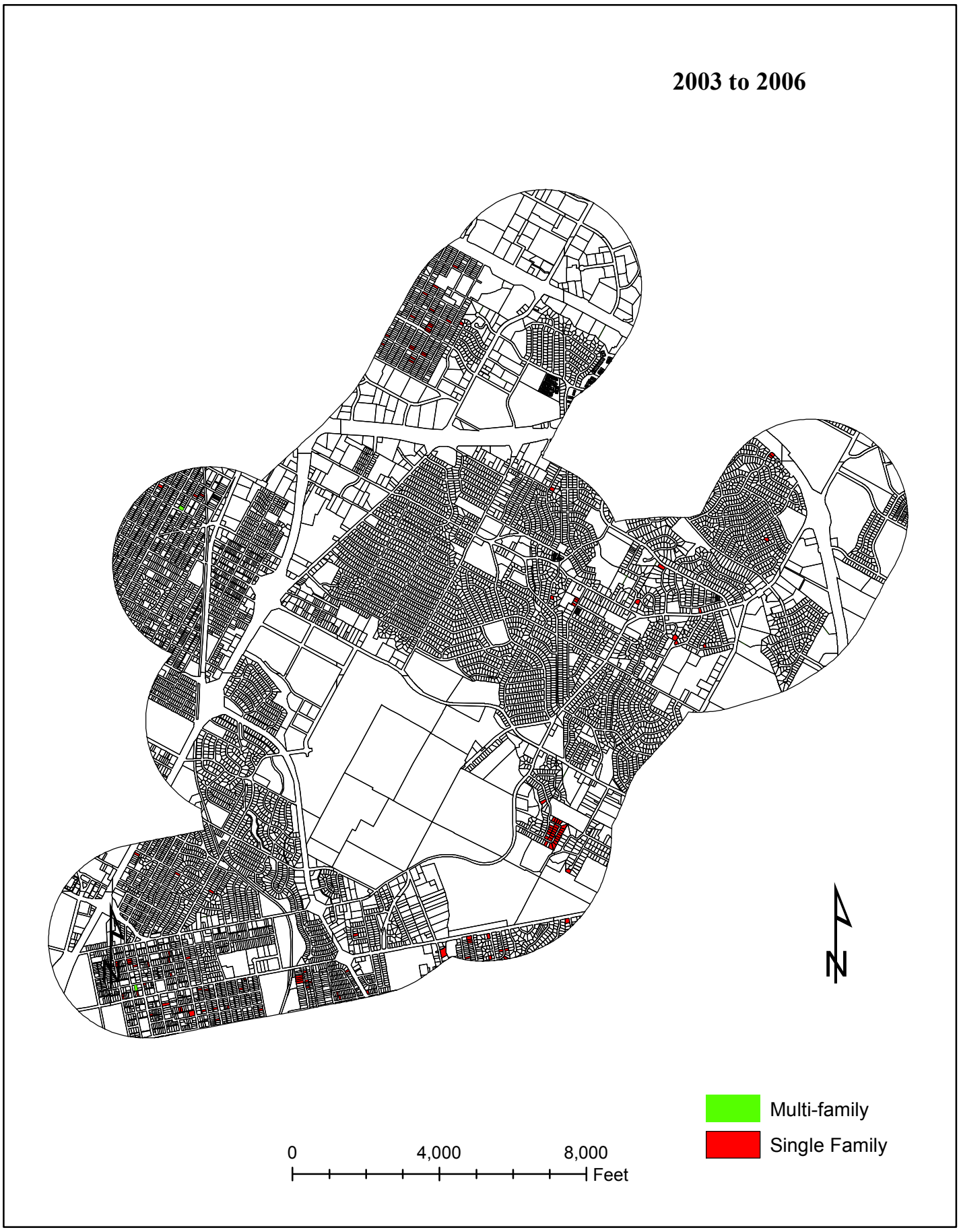
Undeveloped Land to Single or Multi-Family Housing: Northwest Corridor

Undeveloped Land to Single or Multi-Family Housing: North Lamar Corridor

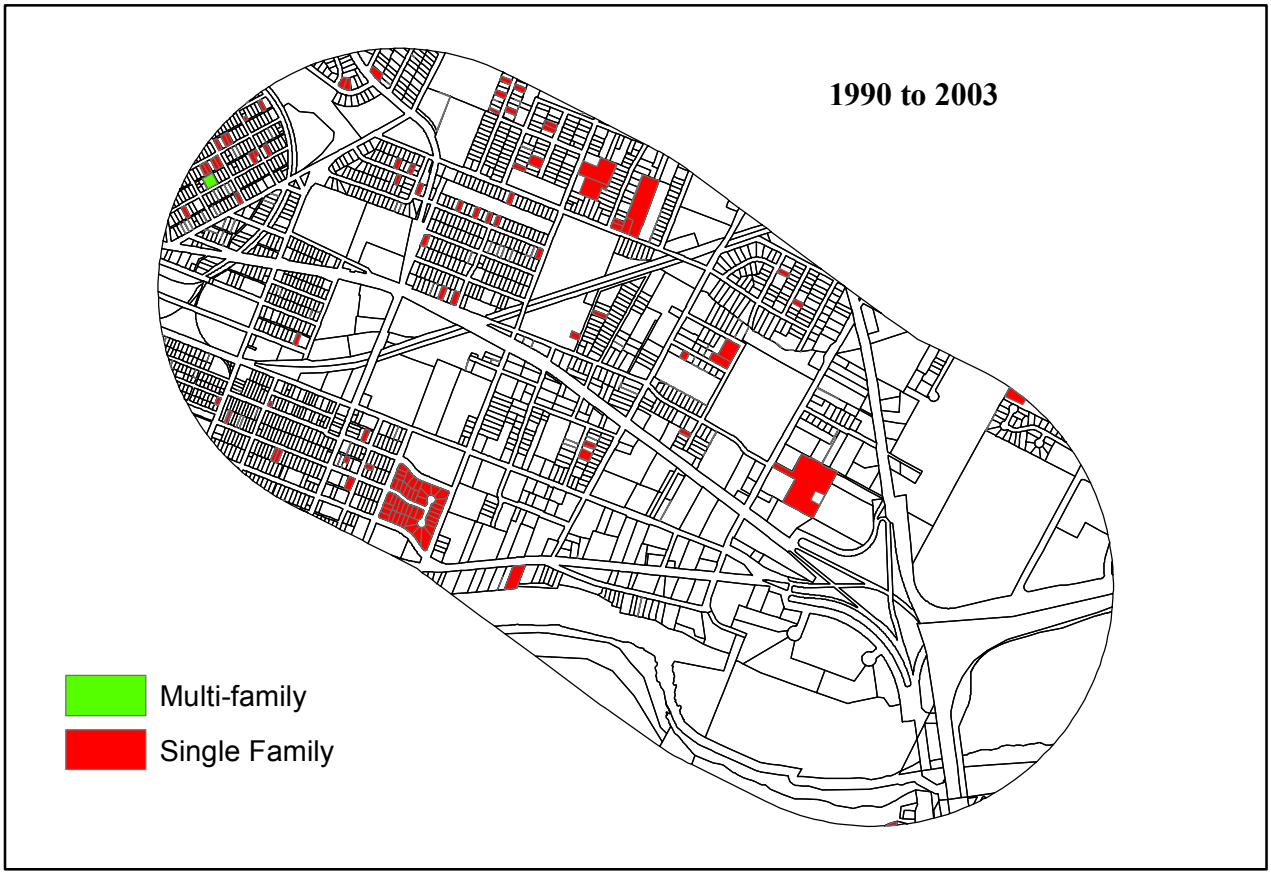


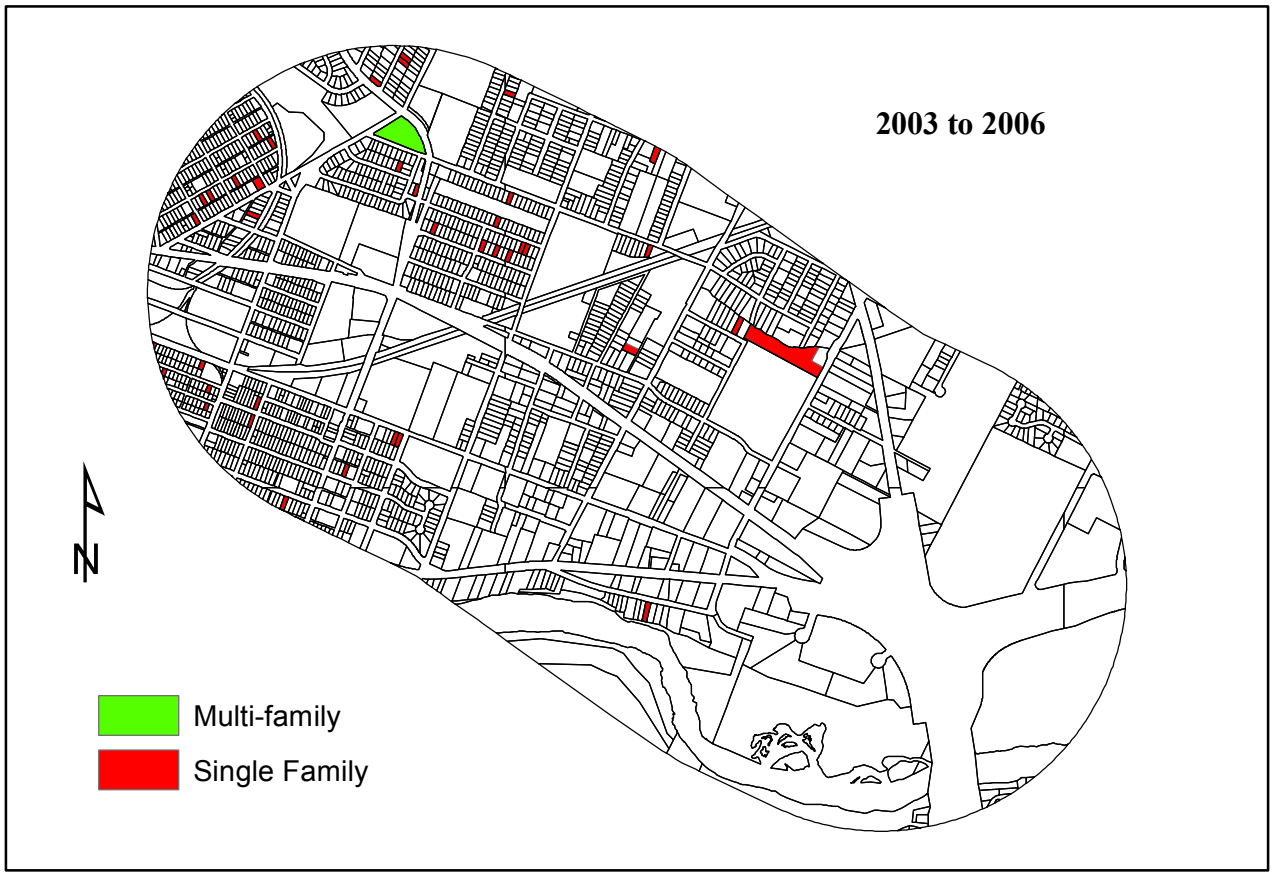
Undeveloped Land to Single or Multi-Family Housing: Mueller Corridor

Undeveloped Land to Single or Multi-Family Housing: Mueller Corridor



Undeveloped Land to Single or Multi-Family Housing in East 7th Corridor





0 2,000 4,000 Feet

After inspection of the intersected data maps, the development of single and multi-family appears to be significant enough to call for changes in the transportation infrastructure for some corridors but not in others. The South Congress/Slaughter, Northwest, and North Lamar corridors experienced strong development in residential housing from 1990 to 2003, while Mueller and East 7th dragged behind. South Congress/Slaughter has also seen some strong development from 2003 to 2006. Most of the changes in area for the two land use types are just reclassification of existing lots, not the development of new homes or apartment complexes. Changes across other land use categories need to be studied to look for other possible explanations for the designation of these future core transit corridors.

Changes across More Land Use Types

In addition to examining the development of single and multi- family housing in future core transit corridor regions, data was processed for changes in other land use types for each of the corridors. Table 2 contains percent change statistics for the South Congress/ Slaughter corridor. In addition to single and multi-family housing, and undeveloped land, all data tables contain information for the following land use types:

- Civic—institutional housing, housing, government services, educational, cemeteries, etc.
- Commercial—Wholesale/retail goods and services
- Industrial-- manufacturing, warehousing, miscellaneous industrial
- Office
- Open space- parks, golf courses, camp grounds, preserves
- Streets and roads (including transportation facilities)

Table 2. Change in Land Use for the South Congress/ Slaughter Corridor, 1990-2006

South Congress/ Slaughter		
Land Use Type	***Change (90-03)***	***Change (03-06)***
Civic	61.89%	4.94%
Commercial	92.89%	48.88%
Industrial	-66.65%	1.86%
Multi-family	256.05%	32.86%
Office	-13.69%	46.72%
Open Space	91.08%	15.60%
Single Family	5.17%	4.72%
Streets and Roads, Transportation	407.20%	3.48%
Undeveloped	-40.56%	-27.56%

The South Congress/Slaughter corridor experienced greater change in land use from 1990 to 2003 than any other of the corridors studied. Civic, commercial, multi-family, and roads all expanded greatly while industrial, office, and undeveloped land all decreased significantly. The

2003-06 time period saw a rebound of office land use as well as strong continuing growth for commercial, multi-family, and open space land use. Undeveloped land continued to decline rapidly. Table 3 contains statistics for change in land use for the Northwest corridor.

Table 3. Change in Land Use for the Northwest Corridor, 1990-2006

Northwest		
Land Use Type	***Change (90-03)***	***Change (03-06)***
Civic	46.55%	3.21%
Commercial	60.79%	5.09%
Industrial	-46.81%	-3.29%
Multi-family	31.73%	-1.69%
Office	32.38%	11.73%
Open Space	33.07%	-2.23%
Single Family	-17.95%	0.03%
Streets and Roads, Transportation	192.76%	-0.78%
Undeveloped	-79.79%	-22.79%

Most of the land use types increased significantly from 1990 to 2003 at the expense of industrial, single family, and undeveloped land. Roads and transportation facilities increase at a very high percentage for all but one of the corridor regions in the study (Mueller is the exception). Improvement in the quality of data capture and the inclusion of transportation facilities for 2003 data probably accounts for most of the change in road land use. While more transportation was probably built in these regions over the 13 year period, its believe that the infrastructure increase two to four fold in terms of land use over those years. Land use didn't change much in the northwest corridor from 2003 to 2006, office space saw a decent increase, while undeveloped land continued to decline. Table 4 will show land use change data for the North Lamar corridor.

Table 4. Change in Land Use for the North Lamar Corridor, 1990-2006

North Lamar		
Land Use Type	***Change (90-03)***	***Change (03-06)***
Civic	26.47%	2.49%
Commercial	45.10%	28.95%
Industrial	9.16%	-11.26%
Multi-family	42.02%	0.71%
Office	79.60%	10.37%
Open Space	51.78%	5.65%
Single Family	-18.47%	0.65%
Streets and Roads, Transportation	243.76%	4.44%
Undeveloped	-56.09%	-23.92%

The North Lamar corridor changes look very similar to the neighboring Northwest corridor. Single family and undeveloped land decreased while the other categories increased significantly from 1990 to 2006. One difference is that industrial land use actually increased in the North Lamar corridor during this time while it decreased significantly in the Northwest Corridor. Commercial and office land use increases rapidly from 2003 to 2006 while other categories see incremental increases. Industrial and undeveloped lands decrease, as seen in previous corridors. Table 5 contains the data for the Mueller corridors region, an area that behaves very differently than the other corridor regions studied.

Table 5. Change in Land Use for the Mueller Corridors, 1990-2006

Mueller		
Land Use Type	***Change (90-03)***	***Change (03-06)***
Civic	11.77%	9.87%
Commercial	-18.29%	-1.54%
Industrial	40.62%	14.65%
Multi-family	2.94%	1.22%
Office	79.01%	-36.90%
Open Space	6.12%	18.00%
Single Family	-25.41%	0.25%
Streets and Roads, Transportation	26.60%	1.64%
Undeveloped	20.86%	5.88%

Land dedicated to roads and transportation does not increase at the same rates as the other corridors. Commercial and single family land use decrease significantly from 1990 to 2003 while office and industrial increased strongly. Surprisingly, undeveloped land also increased over both time periods. Office space lost ground from 2003 to 2006 while open space picked up a great amount of area. Table 6 shows the land use changes in the small East 7th corridor.

Table 6. Change in Land Use for the East 7th Corridor, 1990-2006

East 7th		
Land Use Type	***Change (90-03)***	***Change (03-06)***
Civic	-3.00%	1.29%
Commercial	-35.91%	-9.37%
Industrial	-4.88%	-4.35%
Multi-family	-9.23%	83.84%
Office	-21.85%	28.80%
Open Space	-8.52%	-8.20%
Single Family	-17.98%	1.10%
Streets and Roads, Transportation	236.17%	-2.46%
Undeveloped	-56.46%	0.65%

Almost unbelievably, every land use type examined fell in area from 1990 to 2003 except for roads and transportation. Unless unstudied land use types such as utilities, mining, or water also gained great area, this appears to be more of a data quality issue rather than a proliferation of transportation infrastructure. Roads land use actually decreases slightly from 2003 to 2006 while multi-family and office space experiences rapid growth.

CONCLUSION

No conclusive evidence was found in the examination of land use changes to say that the development of core transit corridors was tied to land use. The only consistency across all five regions was the expansion of transportation infrastructure (whether as a result of data quality improvement or not). Needless to say the expansion of transportation does not explain why transportation was expanded. The best land use explanation would be increases in civic, commercial and multi-family as these categories saw major increases in the South Congress/Slaughter, Northwest, and North Lamar corridors. Trends in the development of single and multi-family may have some effect, but certainty not at the same degree across corridor regions. Many of the changes can be attributed to changes in the data quality rather than new subdivisions, apartments, or condominiums.