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Enhancement of Predictive Capability of Transit Boardings Estimation and Simulation Tool (TBEST) Using Parcel Data: An Exploratory Analysis

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Enhancement of Predictive Capability of Transit Boardings Estimation and Simulation Tool (TBEST) Using Parcel Data: An Exploratory Analysis

by

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ABSTRACT

TBEST is a comprehensive third generation transit demand forecasting model, developed by the FDOT Public Transit Office (PTO) to help transit agencies in completing their Transit Development Plans (TDPs). The on-going project funded by FDOT, related to TBEST, aims at further enhancing the capabilities of the TBEST model based on additional opportunities identified by the research team. The project focuses on enhancing TBEST's capabilities in following areas: 1) Improving the precision of socio-demographic data by using property appraisal data (parcel data) and, 2) Improving the quality of data regarding trip attraction. Based on the improvement areas, this study aims at performing an exploratory analysis to 1) Identify the differences in activity levels (population and employment) within transit stop buffers due to change in input data i.e. from aggregate census data to disaggregate parcel data. 2) Explore various strategies (development of employment based trip attraction and, parcel land use based trip attraction and exploring how special generators are dealt with in the past studies) to enhance the trip attraction capability of the TBEST model. The results obtained from this analysis provide insights on the strategies and helps define suggestions to further enhance the precision of TBEST model. The results show that use of parcel level data improves the accuracy in capturing the activity levels within the catchment area of each stop. The results also suggest use of parcel land use based trip attraction for stops with special

generators or use of interaction variable (interaction between special generator dummy and size (square footage etc.) of the special generator) to enhance the trip attraction capability of the TBEST model.

CHAPTER 1 INTRODUCTION

1.1 Background

The 2008 American Community Survey (ACS) shows that public transportation is used as the main mode of travel to work by only 5 % of the population of age greater than 16. But still, public transportation serves millions of people in the United States as the only means of transportation. Given the demand for public transportation, Transit agencies strive to benefit every segment of American society — individuals, families, communities, and businesses by providing efficient and convenient transit services. As per the statute detailed in Public Transit 14-73.001, all transit agencies in Florida are required to provide Transit Development Plans (TDPs). TDP is a planning document, which includes ridership forecasts for the following ten years using the transit demand estimation tool that is either approved or provided by the Florida Department of Transportation (FDOT). Transit Boardings Estimation and Simulation Tool (TBEST) is the travel demand forecasting tool for public transportation developed by the FDOT Public Transit Office (PTO) to help transit agencies in completing their TDPs.

1.2 TBEST

TBEST is a comprehensive third generation transit demand forecasting model, which provides forecasts of ridership at each stop specific to route and direction, thus making it more accurate and detailed as compared to other existing transit planning models. Stop-level ridership can also be aggregated to route, segment, and system level. TBEST is truly user friendly as it is interfaced with ArcGIS, which allows a user to easily change or edit the route and stop configuration. TBEST is capable of evaluating the impact of service span, frequency, fare pricing and speed on the transit ridership. T-BEST accounts for spatial accessibility by considering circular buffers around individual stops to identify the market for the transit system. More details on TBEST model and its methodology are provided in Chapter 3.

The on-going project funded by FDOT, related to TBEST, aims at further enhancing the capabilities of the TBEST model based on additional opportunities identified by the research team. The project focuses on enhancing TBEST's capabilities in two specific areas. The first area includes enhancing the precision of socio-demographic data by using disaggregate parcel level spatial representation to capture the activity levels in transit stop buffers. Currently the TBEST model uses the 2000 Census data at the block group level (aggregate) with an assumption of uniform spatial distribution of population over an entire block group to capture the socio-economic characteristics within the stop buffer. This aggregate level spatial representation does not completely capture the variation in land use within a transit stop buffer, which could lead to the inaccurate estimation of activity levels. Disaggregating the block group level socio-demographic data to the parcel level should enhance the stop level predictive capability of TBEST as the parcel data gives a more realistic spatial distribution of each land use. The other modification to TBEST involves improving the quality of data regarding trip attraction. At present, employment and special generator[1] dummy variable are the only variables used in the TBEST model to measure transit trip attractiveness. We know that employment may account for workers accessing a particular land use, but employment

[1] Special generators are defined as land uses that do not generate or attract trips at the same rate as other land uses

does not take into account customers or visitors accessing that land use as they vary depending on the activity levels at that land use. Similarly, the special generator dummy variable does not take into account the activity levels at each special generator. Thus, we can say that employment and special generator dummy variable does not completely explain the activity levels and total trip attraction to a destination. Strategies for enhancement of the data supporting trip attraction can be developed by exploring a better way to handle special generators such that they are defined in terms of trip attraction rather than as a dummy variable in the model. Employment based trip rates and trip rates obtained using the Institute of Transportation Engineers' (ITE) trip generation manual and disaggregate parcel level data would help in developing strategies to improve the trip attractiveness of the TBEST model.

1.3 Objectives

Demographics and socioeconomic characteristics such as population and employment are the primary inputs for the TBEST model (and practically for all travel models) to estimate potential transit users. Lack of precision in such input datasets would result in biased and inaccurate forecasts.

As the ongoing project on TBEST model enhancement aims at moving to parcel level data, one of the objectives of this paper is to disaggregate block group census data to the parcel level and to identify the differences in activity levels (population and employment) around transit stops due to change in input data i.e. from aggregate census data to disaggregate parcel data.

The second objective of this research is to explore possible options to improve trip attraction capabilities. In order to meet this objective, the study examines the employment based trip attraction and the development of parcel land use based trip attraction using the ITE trip generation manual, parcel level data and the 2001 National Household Travel Survey (NHTS) data for all the time periods used in the TBEST model. The study also focuses on improving the predictive capability of the TBEST model by exploring how special generators are dealt with in various regional travel demand models and transit analysis studies, and develops strategies on how to deal with special generators in the TBEST model.

1.4 Methodology

The current research study will perform exploratory analysis on the objectives listed above. The results obtained from the analysis performed will then be used to define suggestions that may be implemented to further enhance the precision of TBEST model in the future. The explorative analysis will be performed on Duval County, Florida. ArcGIS 9.3 will be used to apply the disaggregate census data to parcel level and to capture the differences in activity level due to change in input data. The exploratory analysis of the strategies for trip attraction capability enhancement will be performed using ArcGIS. 2000 census data, parcel data, InfoUSA employment data, transit network data, ITE trip generation manual and 2001 NHTS data will be used in this research. All these datasets will be discussed in detail in Chapter 2.

1.5 Outline of the Thesis

This thesis contains six chapters. Chapter 1 provides the introduction of the TBEST Model and the ongoing TBEST enhancements. The first section introduces the importance of transit ridership forecasting tool such as TBEST. Following that is a brief introduction of the TBEST Model and identified opportunities for the enhancement of

TBEST's capabilities. Chapter 2 provides the description of all the datasets used in this paper. Chapter 3 discusses the elements, methodology and the ongoing enhancements of the TBEST model in detail. Following the TBEST Model chapter, Chapter 4 provides the description of strategies used for disaggregating zonal social demographic data to the parcel level. It also discusses the methodology and results of the exploratory analysis to capture the differences in activity levels (population and employment) using aggregate census data, disaggregate parcel data and InfoUSA employment data. Chapter 5 discusses the possible ways (development of employment based trip attraction and, parcel land use based trip attraction and exploring how special generators are dealt with in the past studies) of improving the trip attraction capability of the TBEST model and the results of the exploratory analysis. Chapter 6 provides general conclusions based on the explorative analysis and suggestions for the TBEST model enhancement.

CHAPTER 2 DATA DESCRIPTION

To achieve the objectives mentioned in the introduction section, the following datasets were used in this study.

2.1 Census 2000 Data

Summary File 1 (SF 1) and Summary File 3 (SF 3) of the Census 2000 data made available by U.S. Census Bureau were used for this analysis. SF 1 contains data on age, sex, race, households, families, owned or rented and housing units collected from all people and housing units (100-percent data). Whereas, SF 3 is a sample data collected from about 1 in 6 households and weighted to represent the total population. It consists of 813 detailed tables of Census 2000 social, economic and housing characteristics like education, employment status, income, value of housing unit, year structure built.

Demographic and socio-economic characteristics such as single family population, multi-family population, household size, median income etc were obtained from the detailed tables in SF 1 and SF 3 at the block group level. This data was then joined to the block group shape file obtained from Census 2000 TIGER/Line Data using the unique ID for each block group present in both datasets. The Duval County block group shape file consists of 423 block groups with their respective areas.

2.2 2009 Property Appraisal Data (Parcel Data)

The 2009 Property Appraisal data for Duval County, FL was obtained from the Florida Department of Revenue (DOR). The data includes about 100 land uses broadly classified in to residential, industrial, commercial, agricultural, institutional, government and miscellaneous categories based on the activity or use of the property. Property appraisal contains information on land use, property type, area, physical address, sale value, book value. Since the data describe properties based on their land use, each property can be called as a parcel[2]. Table 1 gives the list of variables available in the property appraisal data (parcel data) used in the analysis.

Table 1 Description of Variables in Property Appraisal Data (Parcel Data)

Variable Name	Variable Description
PARCEL_ID	Unique ID given to each Property (parcel)
DOR_UC	DOR Land Use Code
LND_SQFOOT	Land Square Footage
EFF_YR_BLT	Effective Year Built
TOT_LVG_AREA	Total Living or Usable Area
NO_RES_UNITS	Number of Buildings & Residential Units
PHY_ADDR1, PHY_ADDR2, PHY_CITY and PHY_ZIP	Physical Address of the Property
CENSUS_BK	Census Block Group

The dataset also consist of many variables on sales value, just value, assessed value and property tax which were not required for this analysis. The dataset does not include any information on demographics and socio-economic characteristics in each parcel. Parcel data can help in obtaining a more realistic spatial distribution of population around the transit stops as the location of each land use is known. The dataset includes data for 90,742 parcels of which 75,342 are single family parcels, 2156 are multi-family parcels and 13244 are non-residential parcels. Parcels which were coded as vacant residential and the ones with missing information on land use or property type were deleted for the analysis. Table 2 shows the list of land uses available in the parcel data

[2] Parcel is defined as piece of land described based on the ownership or land use.

Table 2 List of Land Uses Available in Parcel Data

DOR Land Use Code	PROPERTY TYPE
Property Type - Residential	
000	Vacant Residential
001	Single Family
002	Mobile Home
003	Multi-family - 10 units or more
004	Condominiums
005	Cooperatives
006	Retirement Homes
007	Miscellaneous Residential (migrant camps, boarding homes, etc.)
008	Multi-family - less than 10 units
009	Undefined - Reserved for Use by Department of Revenue
Property Type – Commercial	
010	Vacant Commercial
011	Stores, one story
012	Mixed use - store and office or store and residential or residential combination
013	Department Stores
014	Supermarkets
015	Regional Shopping Centers
016	Community Shopping Centers
017	Office buildings, non-professional service buildings, one story
018	Office buildings, non-professional service buildings, multi-story
019	Professional service buildings
020	Airports (private or commercial), bus terminals, marine terminals, piers, marinas.
021	Restaurants, cafeterias
022	Drive-in Restaurants
023	Financial institutions (banks, saving and loan companies, mortgage companies, credit services)
024	Insurance company offices
025	Repair service shops (excluding automotive), radio and T.V. repair, refrigeration service, electric repair, laundries, Laundromats
026	Service stations
027	Auto sales, auto repair and storage, auto service shops, body and fender shops, commercial garages, farm and machinery sales and services, auto rental, marine equipment, trailers and related equipment, mobile home sales motorcycles, construction vehicle sales.
028	Parking lots (commercial or patron), mobile home parks
029	Wholesale outlets, produce houses, manufacturing outlets
030	Florist, greenhouses
031	Drive-in theaters, open stadiums
032	Enclosed theaters, enclosed auditoriums
033	Nightclubs, cocktail lounges, bars
034	Bowling alleys, skating rinks, pool halls, enclosed arenas
035	Tourist attractions, permanent exhibits, other entertainment facilities, fairgrounds (privately owned).
036	Camps
037	Race tracks; horse, auto or dog
038	Golf courses, driving ranges
039	Hotels, motels
Property Type – Industrial	
040	Vacant Industrial
041	Light manufacturing, small equipment manufacturing plants, small machine shops, printing plants
042	Heavy industrial, heavy equipment manufacturing, large machine shops, foundries, steel fabricating plants, auto or aircraft plants
043	Lumber yards, sawmills, planing mills
044	Packing plants, fruit and vegetable packing plants, meat packing plants
045	Canneries, fruit and vegetable, bottlers and brewers distilleries, wineries
046	Other food processing, candy factories, bakeries, potato chip factories
047	Mineral processing, phosphate processing, cement plants, refineries, clay plants, rock and gravel plants.
048	Warehousing, distribution terminals, trucking terminals, van and storage warehousing
049	Open storage, new and used building supplies, junk yards, auto wrecking, fuel storage, equipment and material storage

Table 2 Continued

DOR Land Use Code	PROPERTY TYPE
Property Type - Agricultural	
050	Improved agricultural
051	Cropland soil capability Class I
052	Cropland soil capability Class II
053	Cropland soil capability Class III
054	Timberland - site index 90 and above
055	Timberland - site index 80 to 89
056	Timberland - site index 70 to 79
057	Timberland - site index 60 to 69
058	Timberland - site index 50 to 59
059	Timberland not classified by site index to Pines
060	Grazing land soil capability Class I
061	Grazing land soil capability Class I1
062	Grazing land soil capability Class I11
063	Grazing land soil capability Class IV
064	Grazing land soil capability Class V
065	Grazing land soil capability Class VI
066	Orchard Groves, Citrus, etc.
067	Poultry, bees, tropical fish, rabbits, etc.
068	Dairies, feed lots
069	Ornamentals, miscellaneous agricultural
Property Type - Institutional	
070	Vacant
071	Churches
072	Private schools and colleges
073	Privately owned hospitals
074	Homes for the aged
075	Orphanages, other non-profit or charitable services
076	Mortuaries, cemeteries, crematoriums
077	Clubs, lodges, union halls
078	Sanitariums, convalescent and rest homes
079	Cultural organizations, facilities
Property Type - Government	
080	Undefined - Reserved for future use
081	Military
082	Forest, parks, recreational areas
083	Public county schools
084	Colleges
085	Hospitals
086	Counties (other than public schools, colleges, hospitals)
087	State, other than forests, parks, recreational areas, colleges, hospitals
088	Federal, other than forests, parks, recreational areas, hospitals, colleges
089	Municipal, other than parks, recreational areas, colleges, hospitals
Property Type - Miscellaneous	
090	Leasehold interests (government owned property leased by a non-governmental lessee)
091	Utility, gas and electricity, telephone and telegraph, locally assessed railroads, water and sewer service, pipelines, canals, radio television
092	Mining lands, petroleum lands, or gas lands
093	Subsurface rights
094	Right-of-way, streets, roads, irrigation channel, ditch, etc.
095	Rivers and lakes, submerged lands
096	Sewage disposal, solid waste, borrow pits, drainage reservoirs, waste land, marsh, sand dunes, swamps
097	Outdoor recreational or parkland, or high-water recharge subject to classified use assessment.
Centrally Assessed (Unclassified)	
098	Centrally assessed
Non-Agricultural Acreage	
099	Acreage not zoned agricultural

2.3 2007 InfoUSA Employment Data

The 2007 address-based (disaggregate) employment data provided by InfoUSA was obtained for the entire state of Florida in a point layer shapefile format (each point corresponds to an employer or business). The InfoUSA employment database is a comprehensive database of around 14 million U.S. businesses and is continuously updated using public sources. For each address, InfoUSA provides the information on business name, location, franchise code, industry classification code (Standard Industrial Classification (SIC) System and North American Industry Classification System (NAICS)), the sales volume, Industrial Employment (SIC Code 1 to 39), Commercial Employment (SIC Code 50 to 59), Service Employment (SIC Code 40 to 49, 60 to 99) and Total Employment (SIC Code 1 to 99).

The 2007 InfoUSA employment data with 847,108 records in the entire state of Florida was used as the employment data for the analysis. The businesses in the Duval County were selected using the variable "County_Code" in the InfoUSA data. The Duval County includes 39,649 employer or businesses which were used to obtain the total employment by type associated with each transit stop.

2.4 Jacksonville Transportation Authority (JTA) Transit Network Data

The transit agency selected for this analysis is Jacksonville Transportation Authority (JTA). JTA operates transit service in the city of Jacksonville, Duval County, Florida and the surrounding area with 45 routes and about 6039 stops. The Automatic Passenger Count (APC) data, Schedule data and TBEST model for public transit in Jacksonville was obtained from the JTA for the time period of five months from 5th May 2009 to 4th October 2009 (May Pick). The APC data contains stop arrival times and stop boardings per trip and per route. Since not all the buses in Jacksonville are equipped with APC, the daily boardings for different time periods of the day used in the TBEST model cannot be obtained directly. The APC data was used to derive average boardings per vehicle arrival for different time periods of the day used in the TBEST model. In order to get the total daily boarding, data on total number of vehicle arrivals for each stop was obtained from the JTA TBEST model. There were no matching variables between the APC data and the JTA TBEST model and also the transit network (routes and their respective stops) in JTA TBEST model did not match with the APC data and Schedule data. Therefore, JTA TBEST model was digitized[3] based on the APC data and Schedule data and simultaneously a lookup table (one to one mapping) was prepared to match the stops in APC data with corresponding stops in the JTA TBEST model. Once all the routes and stops were digitized, transit route segments were created in a line layer format and their respective transit stops were created in point layer format. The lookup table was then used to get the total boarding at each stop for different time periods of the day used in the TBEST model. The analysis in this paper will be performed for four routes shown in Table 3 as this study aims at exploring the enhancement strategies

Table 3 Details of Routes Selected for the Exploratory Analysis

No	Route No	Route Description	Number of Stops
1	R5	Murray Hill-Regency -FCCJ - UNF	90
2	P7	Dunn - FCCJ North/Normandy	125
3	U2	University Boulevard Connector	74
4	F1	Broadway - Detroit/Florida Ave	80

[3] Stops and routes were added and removed from the JTA TBEST model to match the APC data and Schedule data.

The routes shown in Figure 1 were selected such that none of this routes lies in a single land use (residential, commercial, industrial etc) zone i.e. there are different types of land uses along these routes. Also, population density and employment density (shown in Figure 1) at census block level were taken into consideration while deciding the routes.

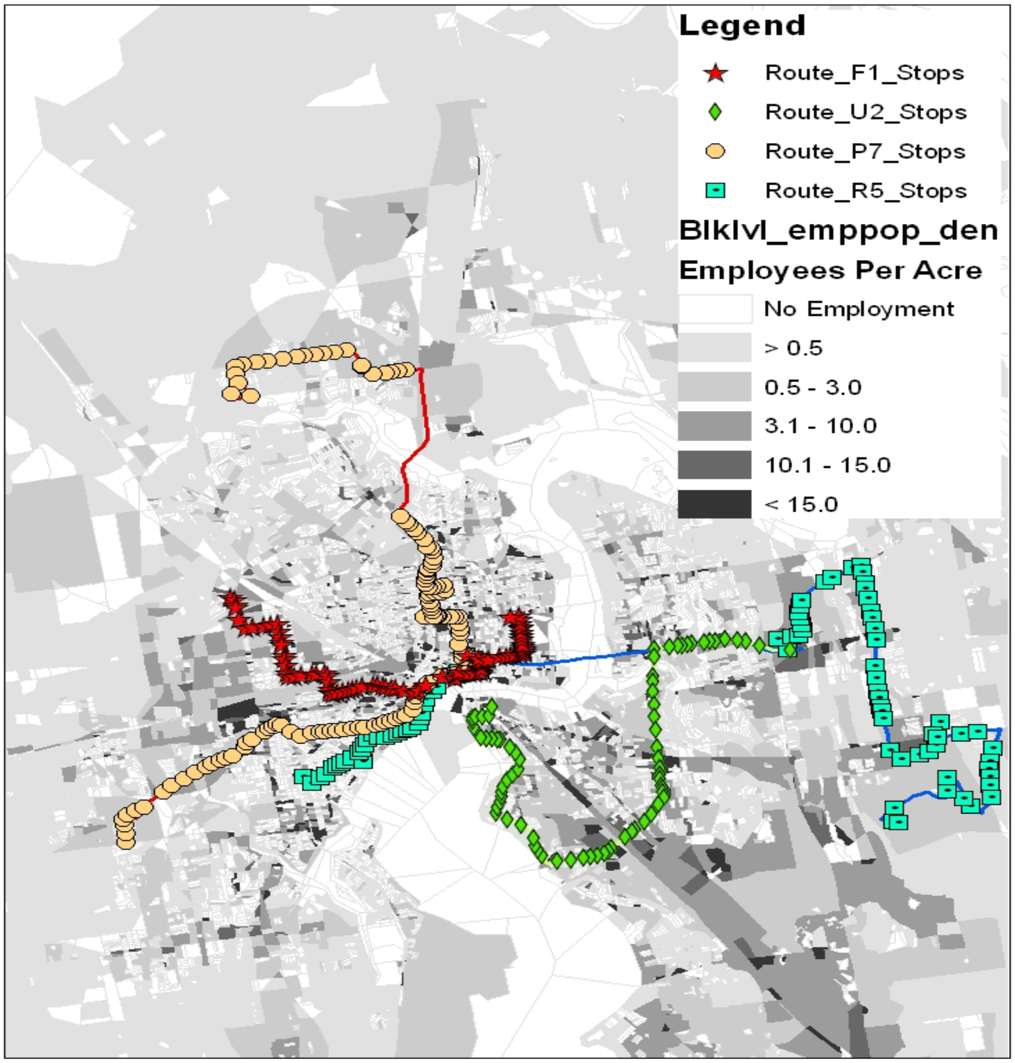


Figure 1 Selected Routes and their Respective Stops

2.5 Institute of Transportation Engineers (ITE) Trip Generation Manual, 8th Edition

The Trip Generation Manual, 8th Edition made available by ITE includes a user's guide as well as two data volumes with land use descriptions, vehicle trip generation rates, equations and data plots. Volume I contains the trip generation rates, plots and equations for land uses 000 through 499. These include the categories Port and Terminal; Industrial/Agricultural; Residential; Lodging; and Recreational. Volume 2 contains the trip generation rates, plots and equations for land uses 500 through 999, which include Institutional; Medical; Office; Retail; and Services categories. These volumes include data from more than 4800 sites. In this manual most of the trip rates are available for one or more of: (1) a weekday, (2) weekday AM peak one-hour[4], (3) weekday PM peak one-hour, (4) Saturday and (5) Sunday. The trip rates for each land use are available for various independent variables like area (square foot, acres), employees, attendees etc.

2.6 2001 National Household Travel Survey (NHTS) Database

The 2001 National Household Travel Survey (NHTS) data made available by U.S. Department of Transportation/Federal Highway Administration, Bureau of Transportation Statistics (BTS), and National Highway Traffic Safety Administration (NHTSA) was used in this study. NHTS collects data on daily trips taken in a 24-hour period and is organized into five different data files namely household file, person file, vehicle file, travel day trip file and long trip file. Records from each data file can be linked to one another using the Household ID number. The 2001 NHTS contain data on the 69,817 households, 160,758 persons, 139,382 vehicles and 642,292 trips. The travel

[4] The peak one hour trip rates (for AM and PM peaks) are defined as the weighted average vehicle trip rate during the hour of highest volume of traffic entering and exiting the site (during the AM and PM hours).

day trip file was used in this study which includes information on purpose of the trip (work, shopping, etc.), means of transportation used (car, bus, subway, walk, etc.), travel time, time of day and day of week when the trip took place. This information will be used to develop the trip rates for different time periods of the day used in the TBEST model.

CHAPTER 3 TBEST MODEL

TBEST modeling software was briefly introduced in Chapter 1. This chapter will describe the features and methodology of the TBEST model (Xuehao et al., 2007 and TBEST 3.2 User Guide, 2009). It will also discuss the opportunities for the enhancement of the TBEST model. TBEST is a third generation transit planning tool developed by the Florida Department of Transportation which, provides forecasts of ridership at each stop specific to route and direction. The features of TBEST model are presented and described below.

3.1 Features of TBEST

1) Direct and Transfer Boardings
2) Time of Day Based Analysis
3) Spatial Accessibility (Socio-Economic Characteristics)
4) Time-Space Network Connectivity
5) Competing and Complementary System Effects
6) GIS-Based Software Tool
7) Performance Measures

One of the distinctive features of the TBEST Model is the fact that it distinguishes between direct and transfer boardings. Transit passengers are either transferring or boarding directly at any given stop. Distinguishing between these two is important because it provides users better understanding of the trip linking that is occurring. Methodology for distinguishing between direct and transfer boardings is as follows.

Firstly, stops are categorized into following options, one with transfer opportunity and one without any transfer opportunity. Using the data from the non-transfer stops, TBEST estimates the direct boardings model, then that model is applied to the transfer stops to estimate the boardings at the transfer opportunity stops. To estimate the transfer boardings, estimated direct boardings are subtracted from the total boardings. TBEST includes separate ridership estimation equations for each time of day and day of week. These times of day incorporated in TBEST are shown in Table 4.

Table 4 Definitions of Time Periods in TBEST

Period No	Name of the Time Period	Time Interval
1	Weekday AM peak period	6:00 - 8:59 AM
2	Weekday off- peak period	9:00 AM - 2:59 PM
3	Weekday PM peak period	3:00 - 5:59 PM
4	Weekday night period	6:00 PM - 5:59 AM (next day)
5	Saturday	12 midnight - 11:59 PM
6	Sunday	12 midnight - 11:59 PM

To account for spatial accessibility, TBEST considers various characteristics such as age, income, auto availability, work status, race etc of the people in the circular buffer area around each stop. This information is used to determine ridership at each stop. TBEST considers the overall connectivity and time-space accessibility of the transit system by measuring the activity opportunities (population and employment) that can be reached within a certain time frame and number of transfers. As the network connectivity i.e. schedule of the transit system may vary with the time of the day, TBEST computes network accessibility for the temporal dimension. The ability of the T-BEST model to account for time-space network connectivity and accessibility makes it the ideal tool for transit ridership forecasting. The competing and complementary effects of the transit system may affect and enhance the ridership at each stop. TBEST clearly accounts for both of these effects in computing stop-level ridership.

T-BEST is interfaced with ArcGIS 9.3 which allows the user to change and edit the socio-economic scenarios, supply attributes, and route and stop configurations. This freedom makes T-BEST a truly user-friendly transit ridership forecasting tool. The output of the T-BEST model gives estimates of several performance measures such as route miles, service miles, service hours, boardings per service mile or hour, and average boardings per service run at the individual route-level and for the whole system. These performance measures can be used to assess the impacts of various socio-economic and supply scenarios on system performance. Appendix A of the TBEST 3.2 User Guide available at http://www.tbest.org/ provides more detailed and complete description of the framework and TBEST methodology.

3.2 Enhancements in TBEST Model

To further improve the predictive capabilities of the TBEST model, following areas of improvement were identified by the research team.

3.2.1 Parcel Level Data Capability

The first improvement area focuses on improving the precision of the input information that the TBEST model uses to determine the activity levels in the transit stop buffers. This can be achieved by using address level data at parcel level of geography instead of the currently used block group level data. Since, there is strong relationship between transit uses and walking distance to transit stops (Sullivan, 1996; Neilson, 1972) using parcel level data will help in capturing actual accessibility of population and activities to the transit stop location. This effort aims at developing a methodology for disaggregating block group level socio-demographic data to the parcel level and using the demographic data the disaggregate parcel level data can be used to enhance the stop level predictive capability of TBEST.

3.2.2 Trip Attraction Capability

This task focuses on enhancing the predictive capability of TBEST by improving the quality of data regarding trip attraction. Currently, employment and special generator dummy variable are the only variables used in TBEST to measure transit trip attractiveness. As discussed earlier, these variables do not completely explain the activity levels and the trip attraction at a destination. The two possibilities for improving the trip attraction quantification are as follows:

1) Exploring a better way to treat special generators such that they are defined in terms of trip attraction rather than as a dummy variable in the model
2) Using employment based trip rates or parcel land use based vehicle trip rates obtained using ITE trip generation manual, 2001 NHTS data and the disaggregate parcel level data

CHAPTER 4 EXPLORING PARCEL LEVEL DATA CAPABILITY

The first effort on improving the forecasting capability of the TBEST model is focused on enhancing the precision of input data by moving from aggregate block group level data to disaggregate parcel level data. The possible benefit of moving to parcel level data would be increase in the accuracy of capturing population distributions relative to the transit system. This chapter aims at disaggregating block group census data to the parcel level and identifying the differences in activity levels (population and employment) within transit stop buffers due to change in input data i.e. from aggregate census data to disaggregate parcel data. To capture the differences in activity levels, single family population, multi-family population and total employment were obtained at the following two levels:

1) At the aggregate level, block group level census data and InfoUSA employment data aggregated at block group level were used with an assumption of uniform spatial distribution of population and employment over the entire block group.
2) At the disaggregate level, parcel level data with population for each parcel (assigned based on the strategies discussed in table 5) and address level InfoUSA employment data were used.

4.1 Methodology

As discussed in the data section, parcel data does not have information on the number and characteristics of the population. As the main objective of this analysis is to compare the demographics and employment captured by using aggregate block group census data and disaggregate parcel data, demographics in each residential parcel is required to determine the population within the catchment area of the transit system (routes and stops). Therefore, population from the 2000 Census data at the block group level of geography is applied to each parcel[5].

4.1.1 Block Group Level Demographic Disaggregation

Table 5 gives the strategies used for assigning block group level census population to each parcel. As the assignment strategies are different for single family parcels (land use code 001 to 005), multi-family parcels (land use code 003 & 008) and retirement homes and miscellaneous residential parcels (land use code 006 & 007), three point layer files for single family (75,342 parcels), multi-family (2,156 parcels) and retirement homes parcels (2 parcels) were created.

Table 5 Strategies for Assigning Block Group Level Census Population to Parcels

Land Use Code	Residential Use	Basis of Allocation	Assignment formula
000	Vacant Residential	Dwelling unit	0
001	Single Family	Dwelling unit	Block group single family population divided by sum of parcels per block group
002	Mobile Home	Dwelling unit	
004	Condominiums	Dwelling unit	
005	Cooperatives	Dwelling unit	
003 & 008	Multi-family	Dwelling unit	Block group multi-family population divided by total number of multifamily dwelling units in each block group times number of dwelling units in that parcel
006 & 007	Retirement Homes and Miscellaneous Residential (migrant camps, boarding homes, etc.)	Square footage	Block group quarters population divided by square footage times parcel square footage.

Single family population and multi-family population for each block group were obtained from 2000 Census data. Based on the uniform spatial distribution concept, single family

[5] There is almost a decade difference between the datasets: 2000 census data and 2009 parcel data. This difference can be eliminated by using the information on the built year of the parcel. The information on built year is missing for almost 10,000 parcels in Duval county parcel data. Therefore, the results of this analysis need to be interpreted with caution.

and multi-family population for each block group was assigned to the single family and multi-family parcels within that block group. For single family parcels, spatial join analysis was performed between the block group census data and single family parcels to obtain the number of parcels in each block group. The population for each single family parcel was obtained by dividing the single family population of the block group in which the parcel is spatially distributed by the total number of single family parcels in that block group.

Table 6 Frequency Distribution of Number of Dwelling Units in Multi-Family Parcels

Number of Dwelling Units	Frequency	Percent Distribution	Average Area (Sq.ft.)
2	955	44.3	1920.13
3	335	15.5	2883.04
4	618	28.7	3571.49
5	64	3.0	4382.02
6	53	2.5	5100.13
7	13	.6	6239.23
8	49	2.3	5680.08
9	2	.1	6983.50
10 to 50	38	1.8	15026.58
Greater than 50	29	1.3	106460.69
Total	**2156**	**100.0**	

For multi-family parcels, the frequency distribution of number of dwelling units and average area shown in table 6 were reviewed to see if there are large developments which might cross multiple block groups. Based on this review, the number of dwelling (residential) units for each parcel was used to obtain the population for each multi-family parcel. For multi-family parcels, spatial join analysis was performed between the block group census data and multi-family parcels to obtain the total number of multi-family residential units in each block group. The population for each multi-family parcel was obtained by dividing the multi-family population of block group in which the parcel is spatially distributed by the total number of multi-family residential units in that block group and then multiplying the ratio with number of residential units in each parcel.

These strategies can only be used to assign population to the parcels; as they do not differentially distribute the other social demographic characteristics of the household. To achieve the objectives of understanding how well the parcel data represents the demographics for the transit boarding models, the analysis was carried out at two levels: Stop level and Route level

4.1.2 Stop Level Analysis

In stop level analysis, socio-economic data is computed for each stop in the transit system. Stop level analysis was considered because transit use is highly related to accessibility of the population and activities to the transit stop. In this analysis, point layer file of transit stops is used and buffers are generated around each stop to capture population and employment in the catchment area of each stop which generally represent the market to the transit system. Three catchment areas (buffer) of 200 meters ($1/8^{th}$ of a mile), 400 meters ($1/4^{th}$ of a mile) (Murray, 1998; Murray, 2001and Xuehao et.al, 2007) and 800 meters (1/2 of a mile) (Zhao, 2003; McDonnell, 2006 and Reese, 2007) were used for this analysis. In each of these buffers, single family population, multi-family population and total employment were obtained at both aggregate level and disaggregate level[6].

At aggregate level, it is assumed that single family population, multi-family population and employment are uniformly distributed over entire block group. For this

[6] The overlapping of the transit stop buffers is not considered in the computation of population and employment within each stop buffer. As the overlapping issue is very important for the transit demand modeling, the overall implication from this analysis may change.

analysis, buffers were generated around each stop and union was performed between the stop buffers and the underlying block group level census polygon layer file. This divides the stop buffers into parts (fractions) based on the census block group boundary (shown in Figure 2). The population and employment for each part (fraction) is calculated based on the area-based fractional computation and then aggregated for each stop to determine the single family population, multi-family population and total employment captured by each stop buffer.

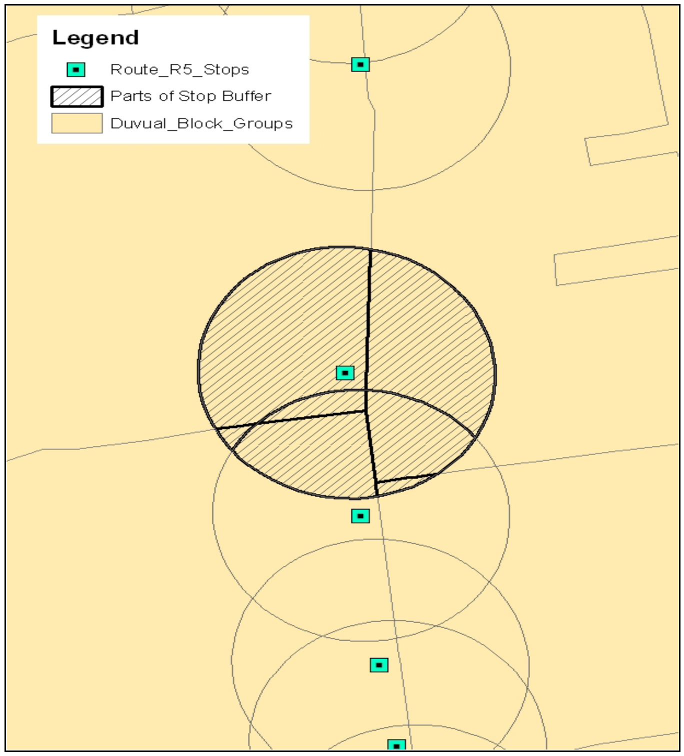


Figure 2 Stop Level Analysis at Aggregate Level

At disaggregate level, the assumption of uniform spatial distribution of population and employment over entire block group is relaxed as the parcel data when used in conjunction with census data provides the population location and address level InfoUSA data provides the employment location. In this analysis, buffers were generated for each stop and the stop buffers were spatially joined to the single family and multi-family parcel point layer files to determine the single family population and multi-family population in the stop buffer. Point layer file of 2007 InfoUSA employment data was also spatially joined to the stop buffers to determine the total employment for each stop buffer. Figure 3 shows an example of the stop buffer and spatial distribution of single family parcels, multi-family parcels and InfoUSA employment data within the stop buffer.

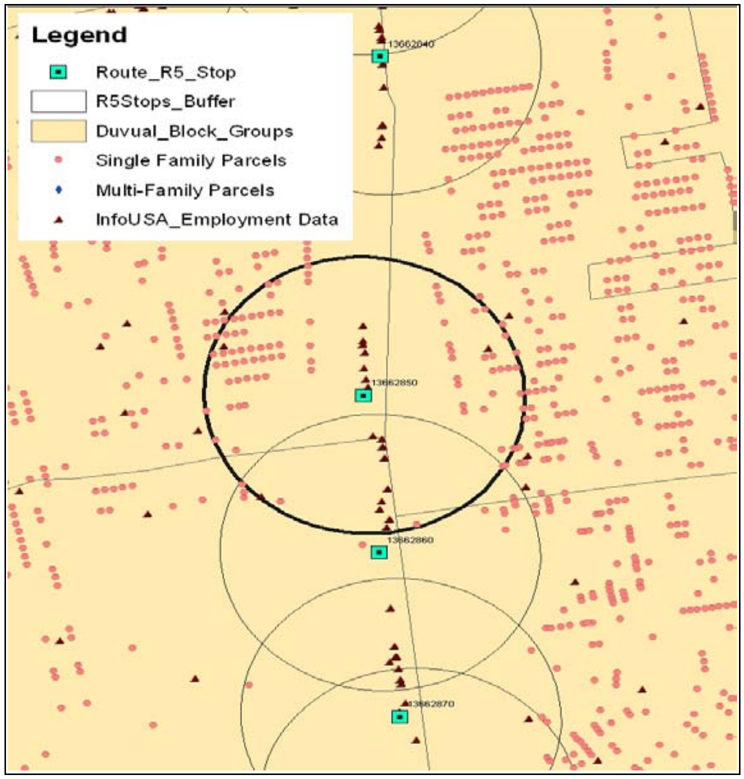


Figure 3 Stop Level Analysis at Disaggregate Level

4.1.3 Route Level Analysis

In route level analysis, socio-economic data is computed for each route in the transit system. The route level analysis was also performed for three catchment areas (buffer) of 200 meters (1/8th of a mile), 400 meters (1/4th of a mile) and 800 meters (1/2 of a mile) of the routes. In this analysis, line layer file of transit route segments is used and buffers are generated for each route to determine the population and employment in the catchment area of each route. Similar to the stop level analysis, single family population, multi-family population and total employment within route buffers were obtained at aggregate level and disaggregate level.

As the assumption of uniform spatial distribution exist at aggregate level, buffers were generated around each route segment and union was performed between the route buffers and the underlying block group level census polygon layer file. This divides the route buffers into parts (fractions) based on the census block group boundary (shown in Figure 4). Single family population, multi-family population and total employment falling within each route buffer was then determined based on the area-based fractional computation.

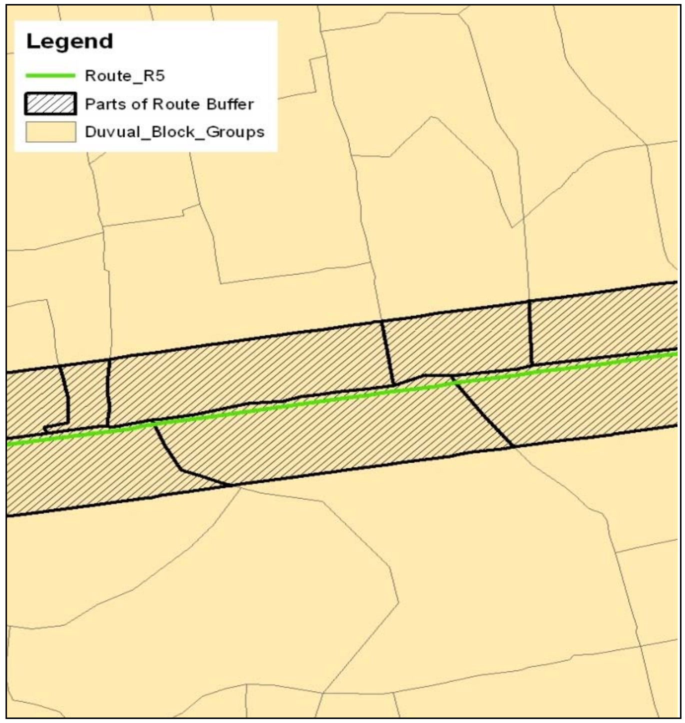


Figure 4 Route Level Analysis at Aggregate Level

The assumption of uniform spatial distribution is relaxed at disaggregate level. In this analysis, buffers were generated for the route segments and were spatially joined to the single family and multi-family parcel point layer files to determine the single family population and multi-family population within each route buffer. Point layer file of 2007 InfoUSA employment data was also spatially joined to the route buffers to determine the total employment within each route buffer. Figure 5 shows an example of the route buffer and spatial distribution of single family parcels, multi-family parcels and InfoUSA employment data within the route buffer.

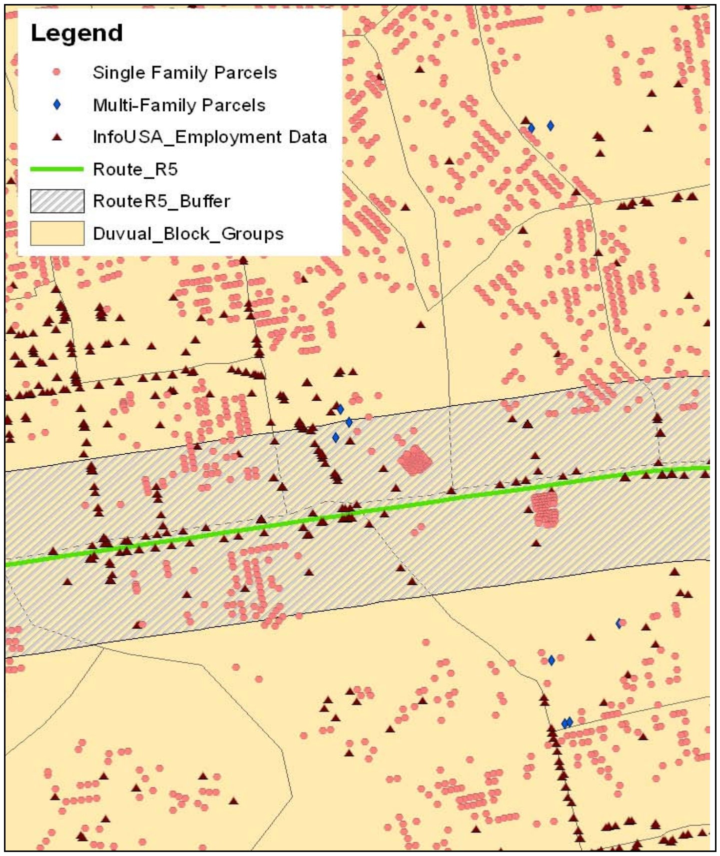
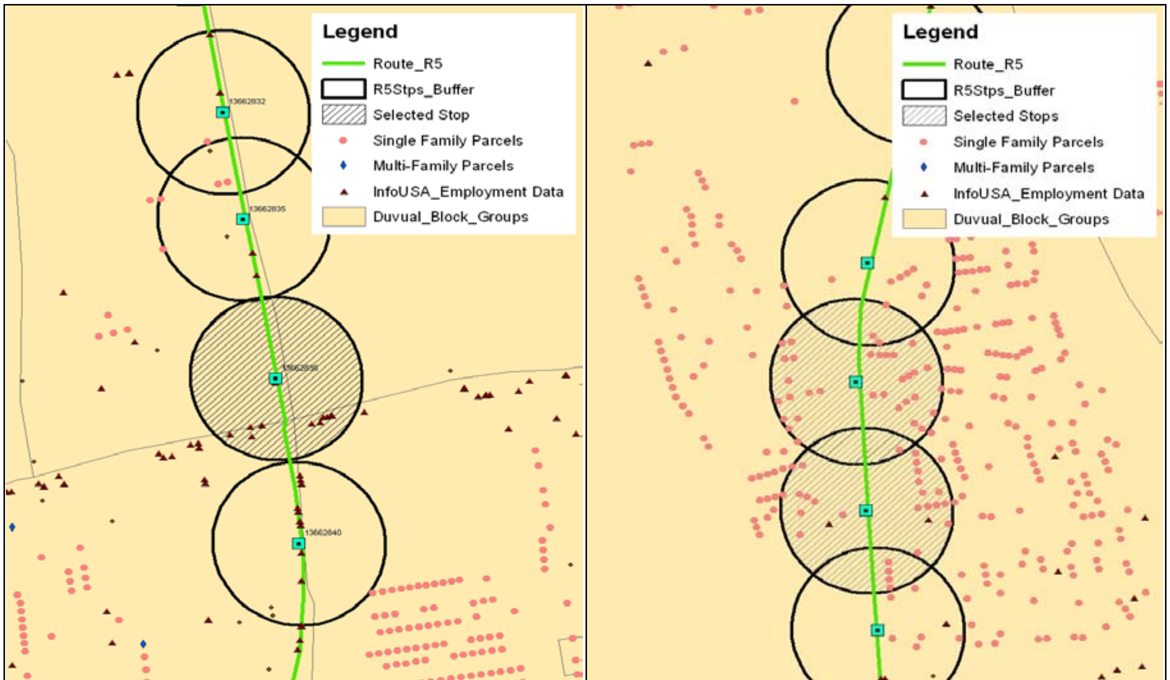


Figure 5 Route Level Analysis at Disaggregate Level

4.2 Results

4.2.1 Results of Stop Level Analysis

This section describes the results of stop level analysis which determines population and employment in the catchment area of each stop at aggregate level (block group) and disaggregates level (parcel).



Case (a)	Case (b)

Figure 6 Examples Explaining the Difference Between Aggregate Level and Disaggregate Level

Figure 6 explains the difference between aggregate and disaggregate level with the help of two examples. The selected stop in case (a) does not have any residential parcel within its buffer and therefore determines zero population at the disaggregate level. Whereas at aggregate level, the stop buffer will show some population as all the block groups overlapping the stop buffer will contribute population based on the assumption of uniform spatial distribution of population in each block group. In case (b), single family population obtained using the parcel data will be much higher than that obtained using block group census data as large number of single family parcels lie in the selected stop buffer. For simplicity, stop level analysis results for only route R5 are discussed in detail. Tables 7, 8 and 9 present the single family population, multi-family population and employment at aggregate and disaggregate level for each stop buffer of route R5. The low value of single family population, multi-family population and total employment at disaggregate level when compared to aggregate level can be explained using case (a) of figure 6. Similarly, the high value of single family population, multi-family population and total employment at disaggregate level when compared to aggregate level can be explained using case (b) of figure 6.The absolute percent differences between the aggregate and disaggregate population and employment, computed for each stop are shown in the tables 7, 8 and 9. It was observed that absolute percent difference decreases with an increase in the size of the catchment area. The absolute percent differences are higher for single family population when compared to multi-family population. This indicates that the single family population is more affected as compared to multi-family population by the use of disaggregate parcel data. Also, the absolute percent differences indicate that the total employment is more affected as compared to population when population and employment within each stop buffer are captured at disaggregate level i.e. using parcel data and address level InfoUSA employment data.

Table 7 Aggregate and Disaggregate Level Single Family Population Computed for Different Sizes of Catchment Area (Buffer) Around Route R5 Stops

No	Stop Name	Single Family Population								
		Buffer 1 (1/8 th mile)			Buffer 2 (1/4 th mile)			Buffer 3 (1/2 mile)		
		Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff
1	F.C.C.J. Kent Campus	145.96	6.41	95.60	597.59	414.28	30.67	2,551.77	2,557.66	0.23
2	Park St. & Glendale St.	166.12	236.52	42.38	661.60	681.24	2.97	2,510.87	2,368.47	5.67
3	Park St. & Pinegrove Ave.	175.48	251.89	43.54	630.27	832.62	32.11	2,725.09	2,911.83	6.85
4	Park St. & Van Wert Ave.	111.05	134.59	21.20	640.26	859.69	34.27	2,884.23	3,335.60	15.65
5	Park St. & Ingleside Ave.	222.60	232.26	4.34	799.90	974.67	21.85	2,871.20	3,798.79	32.31
6	Park St. & Talbot Ave.	241.49	224.30	7.12	854.62	1,159.66	35.69	2,705.77	3,570.86	31.97
7	Park St. & Edgewood Ave.	213.65	271.29	26.98	833.83	1,143.26	37.11	2,538.41	3,413.33	34.47
8	Park St. & Valencia Rd.	162.63	356.26	119.05	695.80	1,085.24	55.97	2,402.37	3,285.81	36.77
9	Park St. & Seminole Rd.	101.94	104.86	2.87	442.67	888.48	100.71	2,150.32	3,081.25	43.29
10	Park St. & Aberdeen St.	46.52	159.75	243.43	216.80	612.51	182.52	1,413.13	2,204.38	55.99
11	Park St. & McDuff Ave.	78.30	103.23	31.84	339.79	394.37	16.06	1,815.57	2,925.24	61.12
12	Park St. & Willow Branch Ave.	83.40	53.78	35.51	341.76	504.86	47.72	1,695.51	3,080.42	81.68
13	Park St. & Cherry St.	88.82	93.75	5.55	358.14	638.25	78.21	1,663.42	2,558.49	53.81
14	Park St. & James St.	92.53	278.52	201.00	384.31	688.01	79.03	1,692.03	2,609.71	54.24
15	Park St. & King St.	84.69	138.12	63.08	357.33	591.23	65.46	1,757.97	2,678.74	52.38
16	King St. & Oak St.	47.05	126.09	168.01	253.79	569.41	124.36	1,429.56	2,271.26	58.88
17	Riverside Ave. & Barrs St.	26.88	76.90	186.15	152.21	340.45	123.68	1,116.52	1,770.75	58.59
18	Riverside Ave. & Stockton St.	24.09	104.42	333.47	113.82	258.72	127.30	994.53	1,355.61	36.31
19	Riverside Ave. & Osceola St.	19.81	94.31	376.09	114.74	334.21	191.26	829.17	1,172.11	41.36
20	Riverside Ave. & Copeland St.	18.08	93.15	415.22	99.87	230.95	131.24	698.09	973.54	39.46
21	Riverside Ave. & Goodwin St.	13.86	34.64	149.96	74.46	197.79	165.64	569.48	889.77	56.24
22	Riverside Ave. & Margaret St.	7.74	8.77	13.26	43.70	169.91	288.84	444.94	660.03	48.34
23	Riverside Ave. & Lomax St.	5.01	67.23	1,241.43	20.91	102.31	389.23	300.05	503.92	67.94
24	Riverside Ave. & Post St.	5.01	0.00	100.00	20.81	102.31	391.69	292.74	388.75	32.80
25	Riverside Ave. & Riverside Park Pl	5.21	0.00	100.00	32.11	23.38	27.18	264.55	299.75	13.31
26	Riverside Ave. & Roselle St.	21.33	0.00	100.00	60.19	0.00	100.00	196.96	182.46	7.36
27	Riverside Ave. & Edison Ave.	22.39	0.00	100.00	75.19	23.25	69.08	230.18	219.92	4.46
28	Riverside Ave. & Jackson St.	22.39	23.25	3.86	89.01	46.50	47.76	235.40	219.92	6.58
29	Riverside Ave. & Stonewall St.	22.39	0.00	100.00	80.99	46.50	42.58	218.67	219.92	0.57
30	Pearl St. & Bay St.	0.00	0.00	0.00	1.50	0.00	0.00	64.62	0.00	100.00
31	Forsyth St. & Julia St.	0.00	0.00	0.00	0.93	0.00	0.00	45.78	0.00	100.00
32	Forsyth St. & Laura St.	0.00	0.00	0.00	0.13	0.00	0.00	41.10	17.00	58.64
33	Forsyth St. & Ocean St.	0.00	0.00	0.00	0.11	0.00	0.00	74.42	68.00	8.63
34	Newnan St. & Adams St.	0.00	0.00	0.00	8.31	0.00	100.00	149.30	80.25	46.25
35	Newnan St. & Duval St.	0.04	0.00	0.00	13.81	17.00	23.13	243.80	80.25	67.08
36	Newnan St. & Ashley St.	1.90	0.00	100.00	19.98	17.00	14.90	386.31	407.81	5.57
37	Newnan St. & Beaver St.	2.61	0.00	100.00	24.48	17.00	30.56	453.08	504.56	11.36
38	F.C.C.J. Station	3.99	0.00	100.00	16.82	0.00	100.00	237.56	283.02	19.14
39	Regency Square Hub	44.20	0.00	100.00	176.80	0.00	100.00	800.62	154.90	80.65
40	9451 S Regency Square Blvd.	51.15	0.00	100.00	204.03	0.00	100.00	1,028.19	263.81	74.34

Table 7 Continued

No	Stop Name	Single Family Population								
		Buffer 1 (1/8 th mile)			Buffer 2 (1/4 th mile)			Buffer 3 (1/2 mile)		
		Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff
41	9550 S. Regency Square Blvd.	51.15	0.00	100.00	204.93	0.00	100.00	785.64	25.06	96.81
42	S. Regency Square Blvd. & Monument Rd.	51.15	0.00	100.00	204.93	0.00	100.00	791.67	824.99	4.21
43	355 Monument Rd.	51.15	0.00	100.00	204.93	0.00	100.00	811.95	889.47	9.55
44	445 Monument Rd.	51.15	0.00	100.00	204.93	0.00	100.00	820.41	889.47	8.42
45	514 Monument Rd.	51.15	0.00	100.00	204.93	25.06	87.77	820.41	826.83	0.78
46	544 Monument Rd.	51.15	0.00	100.00	204.93	12.53	93.89	821.04	87.69	89.32
47	989 Monument Rd.	51.15	0.00	100.00	204.93	0.00	100.00	822.32	87.69	89.34
48	Monument Rd. & Treddick Pkwy.	51.15	0.00	100.00	204.93	0.00	100.00	822.22	238.03	71.05
49	Monument Rd. & Lee Rd.	51.15	162.86	218.39	204.93	588.81	187.32	880.37	1,869.64	112.37
50	1431 Monument Rd.	51.15	187.92	267.38	219.63	400.89	82.53	962.97	1,971.18	104.70
51	1505 Monument Rd.	79.81	0.00	100.00	311.31	114.44	63.24	1,161.93	956.58	17.67
52	St. Johns Bluff Rd. & Monument Rd.	63.68	0.00	100.00	279.76	127.16	54.55	1,185.48	1,093.71	7.74
53	St. Johns Bluff Rd. & Causey Ln.	59.40	0.00	100.00	235.63	82.82	64.85	1,046.80	1,006.42	3.86
54	St. Johns Bluff Rd. & S. Akers Dr.	60.11	152.92	154.40	234.65	356.37	51.87	919.21	979.06	6.51
55	St. John's Bluff Rd. & Lone Star Rd.	60.33	146.40	142.66	236.11	483.53	104.79	913.47	1,042.64	14.14
56	850 St. Johns Bluff Rd.	60.55	76.29	26.01	236.34	343.32	45.26	899.17	1,029.74	14.52
57	St. Johns Bluff Rd. & Craig Industrial Dr.	59.93	38.15	36.35	235.73	152.59	35.27	906.09	584.92	35.45
58	St. Johns Bluff Rd. & Airport Terrace Dr.	60.42	38.15	36.87	236.92	101.72	57.06	1,205.97	355.85	70.49
59	St. Johns Bluff Rd. & Atlantic Blvd.	86.07	0.00	100.00	434.56	25.43	94.15	1,885.47	861.60	54.30
60	St. Johns Bluff Rd. & Theresa Dr.	192.79	0.00	100.00	757.10	344.33	54.52	2,626.81	2,035.48	22.51
61	St. Johns Bluff Rd. & Bradley Rd.	165.95	25.31	84.75	678.74	644.12	5.10	2,444.60	2,929.51	19.84
62	St. Johns Bluff Rd. & Lost Pine Dr.	71.20	14.01	80.32	369.17	93.30	74.73	1,783.01	2,132.50	19.60
63	St. Johns Bluff Rd. & Fraser Rd.	61.04	0.00	100.00	262.03	48.91	81.33	1,129.39	1,137.86	0.75
64	St. Johns Bluff Rd. & Alden Rd.	61.05	7.05	88.45	248.32	65.94	73.45	998.51	845.97	15.28
65	2656 St. Johns Bluff Rd.	53.09	0.00	100.00	223.72	7.05	96.85	944.76	723.41	23.43
66	St. Johns Bluff Rd. & Judicial Dr.	52.88	0.00	100.00	217.07	21.16	90.25	919.66	732.18	20.39
67	St. Johns Bluff Rd. & Saints Rd.	53.39	7.05	86.79	218.10	73.64	66.23	887.10	750.08	15.45
68	St. Johns Bluff Rd. & Beach Blvd.	35.33	0.00	100.00	147.20	0.00	100.00	652.52	118.23	81.88
69	Central Pkwy.& St. Johns Bluff Rd.	33.25	0.00	100.00	136.55	0.00	100.00	577.09	0.00	100.00
70	11655 Central Pkwy.	33.22	0.00	100.00	133.09	0.00	100.00	573.13	162.59	71.63
71	11710 Central Pkwy.	33.22	0.00	100.00	133.09	0.00	100.00	589.72	121.94	79.32
72	11818 Central Pkwy.	33.22	0.00	100.00	141.24	0.00	100.00	673.78	170.01	74.77
73	F.C.C.J. Southside Campus	68.42	0.00	100.00	269.92	80.02	70.36	965.09	927.14	3.93
74	Central Pkwy. & Beach Blvd.	62.28	0.00	100.00	227.28	60.97	73.17	849.91	951.65	11.97
75	Beach Blvd. & Central Pkwy.	47.64	0.00	100.00	197.06	0.00	100.00	786.97	503.53	36.02

Table 7 Continued

No	Stop Name	Single Family Population								
		Buffer 1 (1/8 th mile)			Buffer 2 (1/4 th mile)			Buffer 3 (1/2 mile)		
		Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff
76	12000 Beach Blvd.	42.02	31.66	24.65	173.63	379.77	118.73	724.68	1,078.77	48.86
77	Beach Blvd. & Sans Pareil St.	41.50	8.42	79.70	171.74	249.81	45.46	707.82	809.39	14.35
78	3694 Kernan Blvd.	33.22	0.00	100.00	145.12	67.28	53.64	649.44	1,630.94	151.13
79	Kernan Blvd. & Gehrig Dr.	33.22	116.63	251.09	133.09	975.48	632.94	576.14	2,775.30	381.71
80	Kernan Blvd. & Mantle Dr.	33.22	360.50	985.19	133.09	1,420.81	967.54	547.70	2,933.57	435.61
81	Kernan Blvd. & Hunter's Haven Ln.	33.22	275.68	729.85	133.09	1,092.11	720.57	532.84	2,905.23	445.23
82	Kernan Blvd. & Blue Stream Dr.	33.22	106.03	219.17	133.09	561.96	322.24	532.82	2,216.03	315.90
83	Kernan Blvd. & First Coast Technology Pkwy.	33.22	0.00	100.00	133.09	0.00	100.00	532.82	614.98	15.42
84	UNF Dr. & Alumni Dr.	33.22	0.00	100.00	133.09	0.00	100.00	532.82	0.00	100.00
85	U.N.F. Osprey Landing (U.N.F Dr.)	33.22	0.00	100.00	133.09	0.00	100.00	532.82	0.00	100.00
86	U.N.F. Library (U.N.F. Dr.)	33.22	0.00	100.00	133.09	0.00	100.00	534.90	0.00	100.00
87	U.N.F. Arena (U.N.F. Dr.)	33.22	0.00	100.00	133.09	0.00	100.00	532.82	0.00	100.00
88	Town Center & Brightman Bl	36.99	0.00	100.00	148.21	0.00	100.00	593.33	30.24	94.90
89	Town Crossing & Buckhead Branch	36.99	0.00	100.00	148.21	0.00	100.00	593.33	136.09	77.06
90	Town Center Mall	36.99	0.00	100.00	148.21	0.00	100.00	593.33	60.48	89.81
	Average	56.30	55.88	**129.37**	231.68	255.18	**111.98**	992.28	1,138.02	**60.98**
	Standard Deviation	51.24	90.04		200.15	349.51		727.83	1,102.17	

Table 8 Aggregate and Disaggregate Level Multi-Family Population Computed for Different Sizes of Catchment Area (Buffer) Around Route R5 Stops

No	Stop Name	Multi-family population								
		Buffer 1 (1/8 th mile)			Buffer 2 (1/4 th mile)			Buffer 3 (1/2 mile)		
		Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff
1	F.C.C.J. Kent Campus	7.48	7.33	1.94	24.52	7.33	70.09	143.49	59.09	58.82
2	Park St. & Glendale St.	7.04	0.00	100.00	31.27	0.00	100.00	194.80	163.90	15.86
3	Park St. & Pinegrove Ave.	16.87	0.00	100.00	68.59	61.59	10.20	306.28	330.14	7.79
4	Park St. & Van Wert Ave.	34.73	32.14	7.44	116.80	153.34	31.28	393.79	478.93	21.62
5	Park St. & Ingleside Ave.	46.34	82.13	77.22	160.96	200.36	24.47	433.12	456.64	5.43
6	Park St. & Talbot Ave.	48.79	36.88	24.40	148.11	187.50	26.60	500.10	707.08	41.39
7	Park St. & Edgewood Ave.	36.12	4.86	86.54	126.18	95.03	24.69	563.80	976.43	73.19
8	Park St. & Valencia Rd.	13.71	5.14	62.49	121.86	87.84	27.92	609.53	1,077.80	76.82
9	Park St. & Seminole Rd.	34.62	141.10	307.62	142.00	542.02	281.71	706.27	1,174.15	66.25
10	Park St. & Aberdeen St.	32.64	246.69	655.80	115.97	483.53	316.96	692.88	1,010.58	45.85
11	Park St. & McDuff Ave.	62.14	231.60	272.69	231.34	701.60	203.28	837.58	1,568.37	87.25
12	Park St. & Willow Branch Ave.	65.99	146.50	122.01	283.48	651.08	129.68	926.07	1,773.31	91.49
13	Park St. & Cherry St.	79.97	108.21	35.30	313.50	837.19	167.05	1,061.32	1,942.98	83.07
14	Park St. & James St.	88.69	312.51	252.34	332.53	666.93	100.57	1,164.88	2,037.93	74.95
15	Park St. & King St.	85.60	180.31	110.64	338.95	704.27	107.78	1,269.25	2,192.46	72.74
16	King St. & Oak St.	59.36	172.21	190.13	281.26	622.56	121.35	1,185.41	2,017.23	70.17
17	Riverside Ave. & Barrs St.	15.19	16.65	9.62	160.47	437.65	172.73	1,117.63	1,964.52	75.78
18	Riverside Ave. & Stockton St.	14.30	47.79	234.19	93.98	285.44	203.72	1,066.39	1,981.81	85.84
19	Riverside Ave. & Osceola St.	23.20	172.63	644.00	116.83	391.89	235.42	916.76	1,698.04	85.22
20	Riverside Ave. & Copeland St.	26.80	210.22	684.35	128.95	376.62	192.06	795.94	1,539.37	93.40
21	Riverside Ave. & Goodwin St.	29.04	155.71	436.26	133.52	403.20	201.99	719.85	1,561.25	116.89
22	Riverside Ave. & Margaret St.	31.20	0.00	100.00	126.15	385.91	205.93	672.01	1,321.29	96.62
23	Riverside Ave. & Lomax St.	32.14	60.93	89.55	128.60	60.93	52.62	597.43	1,232.34	106.27
24	Riverside Ave. & Post St.	32.14	60.93	89.55	127.69	60.93	52.28	562.09	1,202.09	113.86
25	Riverside Ave. & Riverside Park Pl	31.84	0.00	100.00	110.67	60.93	44.94	502.47	977.81	94.60
26	Riverside Ave. & Roselle St.	7.57	0.00	100.00	68.39	60.93	10.92	340.05	649.38	90.96
27	Riverside Ave. & Edison Ave.	5.98	0.00	100.00	45.80	0.00	100.00	279.45	179.86	35.64
28	Riverside Ave. & Jackson St.	5.98	0.00	100.00	24.99	49.71	98.92	208.12	58.00	72.13
29	Riverside Ave. & Stonewall St.	5.98	0.00	100.00	27.38	33.14	21.06	207.73	58.00	72.08
30	Pearl St. & Bay St.	25.89	0.00	100.00	96.69	0.00	100.00	349.05	0.00	100.00
31	Forsyth St. & Julia St.	25.89	0.00	100.00	99.38	0.00	100.00	437.52	0.00	100.00
32	Forsyth St. & Laura St.	25.89	0.00	100.00	103.11	0.00	100.00	574.47	39.33	93.15
33	Forsyth St. & Ocean St.	25.89	0.00	100.00	103.20	0.00	100.00	628.23	118.00	81.22
34	Newnan St. & Adams St.	25.89	0.00	100.00	109.32	39.33	64.02	716.09	118.00	83.52
35	Newnan St. & Duval St.	25.71	0.00	100.00	169.34	39.33	76.77	963.67	118.00	87.76
36	Newnan St. & Ashley St.	63.01	0.00	100.00	264.91	39.33	85.15	1,201.06	882.13	26.55
37	Newnan St. & Beaver St.	78.30	0.00	100.00	300.83	39.33	86.92	1,255.98	903.90	28.03
38	F.C.C.J. Station	89.22	0.00	100.00	339.89	0.00	100.00	1,278.86	833.03	34.86
39	Regency Square Hub	30.92	0.00	100.00	123.28	0.00	100.00	603.45	0.00	100.00
40	9451 S Regency Square Blvd.	45.85	0.00	100.00	181.76	0.00	100.00	702.82	0.00	100.00

Table 8 Continued

No	Stop Name	Multi-family population								
		Buffer 1 (1/8 th mile)			Buffer 2 (1/4 th mile)			Buffer 3 (1/2 mile)		
		Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff
41	9550 S. Regency Square Blvd.	45.85	0.00	100.00	183.69	0.00	100.00	660.70	0.00	100.00
42	S. Regency Square Blvd. & Monument Rd.	45.85	0.00	100.00	183.69	0.00	100.00	665.17	0.00	100.00
43	355 Monument Rd.	45.85	0.00	100.00	183.69	0.00	100.00	709.79	0.00	100.00
44	445 Monument Rd.	45.85	0.00	100.00	183.69	0.00	100.00	735.37	0.00	100.00
45	514 Monument Rd.	45.85	0.00	100.00	183.69	0.00	100.00	735.37	0.00	100.00
46	544 Monument Rd.	45.85	0.00	100.00	183.69	0.00	100.00	730.95	0.00	100.00
47	989 Monument Rd.	45.85	0.00	100.00	183.69	0.00	100.00	722.07	1,176.00	62.87
48	Monument Rd. & Treddick Pkwy.	45.85	0.00	100.00	183.69	0.00	100.00	722.73	1,176.00	62.72
49	Monument Rd. & Lee Rd.	45.85	0.00	100.00	183.69	0.00	100.00	639.42	0.00	100.00
50	1431 Monument Rd.	45.85	0.00	100.00	160.16	0.00	100.00	507.26	0.00	100.00
51	1505 Monument Rd.	0.00	0.00	0.00	0.73	0.00	0.00	131.91	0.00	100.00
52	St. Johns Bluff Rd. & Monument Rd.	1.02	0.00	0.00	4.95	0.00	100.00	33.88	0.00	100.00
53	St. Johns Bluff Rd. & Causey Ln.	0.96	0.00	0.00	4.00	0.00	100.00	33.56	0.00	100.00
54	St. Johns Bluff Rd. & S. Akers Dr.	0.92	0.00	0.00	3.99	0.00	100.00	35.75	0.00	100.00
55	St. John's Bluff Rd. & Lone Star Rd.	0.91	0.00	0.00	3.92	0.00	100.00	47.19	0.00	100.00
56	850 St. Johns Bluff Rd.	0.90	0.00	0.00	3.91	0.00	100.00	73.67	0.00	100.00
57	St. Johns Bluff Rd. & Craig Industrial Dr.	0.93	0.00	0.00	3.94	0.00	100.00	98.09	0.00	100.00
58	St. Johns Bluff Rd. & Airport Terrace Dr.	0.91	0.00	0.00	3.88	0.00	100.00	210.97	0.00	100.00
59	St. Johns Bluff Rd. & Atlantic Blvd.	11.36	0.00	100.00	81.60	0.00	100.00	443.04	206.74	53.34
60	St. Johns Bluff Rd. & Theresa Dr.	57.15	0.00	100.00	214.11	0.00	100.00	689.49	454.83	34.03
61	St. Johns Bluff Rd. & Bradley Rd.	51.73	0.00	100.00	190.37	0.00	100.00	660.28	124.04	81.21
62	St. Johns Bluff Rd. & Lost Pine Dr.	9.11	0.00	100.00	62.85	0.00	100.00	392.62	0.00	100.00
63	St. Johns Bluff Rd. & Fraser Rd.	6.66	0.00	100.00	33.84	0.00	100.00	184.17	0.00	100.00
64	St. Johns Bluff Rd. & Alden Rd.	8.45	0.00	100.00	40.99	0.00	100.00	179.18	0.00	100.00
65	2656 St. Johns Bluff Rd.	11.76	0.00	100.00	50.50	0.00	100.00	199.92	0.00	100.00
66	St. Johns Bluff Rd. & Judicial Dr.	11.53	0.00	100.00	52.00	0.00	100.00	207.08	0.00	100.00
67	St. Johns Bluff Rd. & Saints Rd.	12.09	0.00	100.00	53.15	0.00	100.00	220.48	0.00	100.00
68	St. Johns Bluff Rd. & Beach Blvd.	12.24	0.00	100.00	50.97	0.00	100.00	202.63	0.00	100.00
69	Central Pkwy.& St. Johns Bluff Rd.	21.85	0.00	100.00	72.07	0.00	100.00	242.59	0.00	100.00
70	11655 Central Pkwy.	21.97	0.00	100.00	88.02	0.00	100.00	354.10	0.00	100.00
71	11710 Central Pkwy.	21.97	0.00	100.00	88.02	0.00	100.00	363.54	0.00	100.00
72	11818 Central Pkwy.	21.97	0.00	100.00	89.62	0.00	100.00	374.55	0.00	100.00
73	F.C.C.J. Southside Campus	28.88	0.00	100.00	108.51	0.00	100.00	357.81	0.00	100.00
74	Central Pkwy. & Beach Blvd.	27.67	0.00	100.00	106.51	0.00	100.00	395.04	0.00	100.00
75	Beach Blvd. & Central Pkwy.	24.80	0.00	100.00	100.57	0.00	100.00	379.26	0.00	100.00
76	12000 Beach Blvd.	15.62	0.00	100.00	62.10	0.00	100.00	277.85	0.00	100.00
77	Beach Blvd. & Sans Pareil St.	15.99	0.00	100.00	60.12	0.00	100.00	237.51	0.00	100.00

Table 8 Continued

No	Stop Name	Multi-family population								
		Buffer 1 (1/8 th mile)			Buffer 2 (1/4 th mile)			Buffer 3 (1/2 mile)		
		Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff
78	3694 Kernan Blvd.	21.97	0.00	100.00	95.45	0.00	100.00	414.41	0.00	100.00
79	Kernan Blvd. & Gehrig Dr.	21.97	0.00	100.00	88.02	0.00	100.00	379.13	0.00	100.00
80	Kernan Blvd. & Mantle Dr.	21.97	0.00	100.00	88.02	0.00	100.00	361.56	0.00	100.00
81	Kernan Blvd. & Hunter's Haven Ln.	21.97	0.00	100.00	88.02	0.00	100.00	352.39	0.00	100.00
82	Kernan Blvd. & Blue Stream Dr.	21.97	0.00	100.00	88.02	0.00	100.00	352.37	0.00	100.00
83	Kernan Blvd. & First Coast Technology Pkwy.	21.97	0.00	100.00	88.02	0.00	100.00	352.37	0.00	100.00
84	UNF Dr. & Alumni Dr.	21.97	0.00	100.00	88.02	0.00	100.00	352.37	0.00	100.00
85	U.N.F. Osprey Landing (U.N.F Dr.)	21.97	0.00	100.00	88.02	0.00	100.00	352.37	0.00	100.00
86	U.N.F. Library (U.N.F. Dr.)	21.97	0.00	100.00	88.02	0.00	100.00	342.79	0.00	100.00
87	U.N.F. Arena (U.N.F. Dr.)	21.97	0.00	100.00	88.02	0.00	100.00	352.37	0.00	100.00
88	Town Center & Brightman Bl	4.59	0.00	100.00	18.38	0.00	100.00	73.57	0.00	100.00
89	Town Crossing & Buckhead Branch	4.59	0.00	100.00	18.38	0.00	100.00	73.57	0.00	100.00
90	Town Center Mall	4.59	0.00	100.00	18.38	0.00	100.00	73.57	0.00	100.00
	Average	28.17	27.03	**116.60**	115.71	97.41	**102.77**	504.15	428.23	**85.12**
	Standard Deviation	21.48	65.27		82.53	202.32		322.57	657.40	

Table 9 Aggregate and Disaggregate Level Total Employment Computed for Different Sizes of Catchment Area (Buffer) Around Route R5 Stops

No	Stop Name	Total Employment								
		Buffer 1 (1/8 th mile)			Buffer 2 (1/4 th mile)			Buffer 3 (1/2 th mile)		
		Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff
1	F.C.C.J. Kent Campus	40.52	225.00	455.26	141.47	271.00	91.56	506.20	378.00	25.33
2	Park St. & Glendale St.	37.69	0.00	100.00	147.71	236.00	59.77	590.94	603.00	2.04
3	Park St. & Pinegrove Ave.	24.35	2.00	91.79	120.18	20.00	83.36	544.90	454.00	16.68
4	Park St. & Van Wert Ave.	25.68	17.00	33.80	125.05	92.00	26.43	582.10	467.00	19.77
5	Park St. & Ingleside Ave.	58.94	77.00	30.65	187.63	104.00	44.57	526.64	586.00	11.27
6	Park St. & Talbot Ave.	68.53	27.00	60.60	192.88	138.00	28.45	549.98	602.00	9.46
7	Park St. & Edgewood Ave.	52.79	6.00	88.63	183.99	119.00	35.32	572.18	857.00	49.78
8	Park St. & Valencia Rd.	21.96	12.00	45.37	160.42	58.00	63.84	588.63	873.00	48.31
9	Park St. & Seminole Rd.	28.14	2.00	92.89	115.42	55.00	52.35	631.44	683.00	8.17
10	Park St. & Aberdeen St.	2.08	7.00	235.91	18.74	28.00	49.41	473.10	654.00	38.24
11	Park St. & McDuff Ave.	39.69	19.00	52.13	157.59	85.00	46.06	604.94	656.00	8.44
12	Park St. & Willow Branch Ave.	45.17	25.00	44.66	196.96	101.00	48.72	877.57	833.00	5.08
13	Park St. & Cherry St.	56.77	22.00	61.25	224.38	199.00	11.31	1692.21	5303.00	213.38
14	Park St. & James St.	64.21	115.00	79.11	331.74	432.00	30.22	2523.24	5867.00	132.52
15	Park St. & King St.	196.29	305.00	55.38	926.54	636.00	31.36	3267.69	6374.00	95.06
16	King St. & Oak St.	373.91	311.00	16.82	1357.69	5253.00	286.91	3801.06	6081.00	59.98
17	Riverside Ave. & Barrs St.	828.40	4707.00	468.20	2317.41	5358.00	131.21	4441.14	6591.00	48.41
18	Riverside Ave. & Stockton St.	741.06	4942.00	566.88	2434.91	5340.00	119.31	4823.83	7189.00	49.03
19	Riverside Ave. & Osceola St.	330.58	443.00	34.01	1539.82	5379.00	249.33	5068.64	7539.00	48.74
20	Riverside Ave. & Copeland St.	164.69	213.00	29.33	942.09	1062.00	12.73	5039.77	7611.00	51.02
21	Riverside Ave. & Goodwin St.	126.78	251.00	97.98	520.22	1255.00	141.24	4224.58	7785.00	84.28
22	Riverside Ave. & Margaret St.	131.78	383.00	190.63	461.48	1512.00	227.64	3086.60	3318.00	7.50
23	Riverside Ave. & Lomax St.	135.66	389.00	186.75	536.64	1379.00	156.97	2667.69	7337.00	175.03
24	Riverside Ave. & Post St.	135.66	503.00	270.78	570.14	1682.00	195.01	3528.72	7838.00	122.12
25	Riverside Ave. & Riverside Park Pl	143.02	462.00	223.03	983.98	5631.00	472.27	4459.32	8110.00	81.87
26	Riverside Ave. & Roselle St.	733.13	4292.00	485.43	2011.70	5538.00	175.29	6421.19	8511.00	32.55
27	Riverside Ave. & Edison Ave.	771.65	4320.00	459.84	2560.93	5526.00	115.78	7693.26	9525.00	23.81
28	Riverside Ave. & Jackson St.	771.65	888.00	15.08	3066.86	3137.00	2.29	10865.57	9683.00	10.88
29	Riverside Ave. & Stonewall St.	771.65	2362.00	206.10	3002.30	2940.00	2.08	13264.02	13843.00	4.37
30	Pearl St. & Bay St.	2179.65	5164.00	136.92	7803.53	12060.00	54.55	22427.47	32582.00	45.28
31	Forsyth St. & Julia St.	2179.65	1677.00	23.06	8159.73	23225.00	184.63	23196.97	33806.00	45.73
32	Forsyth St. & Laura St.	2179.65	3359.00	54.11	8653.10	23559.00	172.26	26949.30	33555.00	24.51
33	Forsyth St. & Ocean St.	2179.65	863.00	60.41	8665.02	22952.00	164.88	28041.45	36578.00	30.44
34	Newnan St. & Adams St.	2179.65	1797.00	17.56	8394.41	8380.00	0.17	26972.60	32574.00	20.77
35	Newnan St. & Duval St.	2156.05	1915.00	11.18	7035.53	7978.00	13.40	24060.62	32594.00	35.47
36	Newnan St. & Ashley St.	1496.62	1663.00	11.12	5597.52	5878.00	5.01	20419.43	30716.00	50.43
37	Newnan St. & Beaver St.	1258.03	831.00	33.94	5155.92	5664.00	9.85	19258.92	28681.00	48.92
38	F.C.C.J. Station	589.74	735.00	24.63	3045.03	14486.00	375.73	15343.97	23948.00	56.07
39	Regency Square Hub	127.47	2365.00	1755.40	510.83	3227.00	531.71	1998.29	6202.00	210.37
40	9451 S Regency Square Blvd.	123.44	0.00	100.00	495.07	384.00	22.43	1805.83	5994.00	231.92

Table 9 Continued

No	Stop Name	Total Employment								
		Buffer 1 (1/8 th mile)			Buffer 2 (1/4 th mile)			Buffer 3 (1/2 th mile)		
		Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff
41	9550 S. Regency Square Blvd.	123.44	1534.00	1142.72	494.55	1874.00	278.93	1999.98	6228.00	211.40
42	S. Regency Square Blvd. & Monument Rd.	123.44	1033.00	736.85	494.55	1812.00	266.40	1995.41	6797.00	240.63
43	355 Monument Rd.	123.44	81.00	34.38	494.55	1609.00	225.35	1983.80	6543.00	229.82
44	445 Monument Rd.	123.44	235.00	90.38	494.55	855.00	72.89	1979.85	3285.00	65.92
45	514 Monument Rd.	123.44	25.00	79.75	494.55	895.00	80.97	1979.85	3337.00	68.55
46	544 Monument Rd.	123.44	24.00	80.56	494.55	42.00	91.51	1967.20	1610.00	18.16
47	989 Monument Rd.	123.44	17.00	86.23	494.55	281.00	43.18	1941.79	2275.00	17.16
48	Monument Rd. & Treddick Pkwy.	123.44	104.00	15.75	494.55	104.00	78.97	1943.69	1485.00	23.60
49	Monument Rd. & Lee Rd.	123.44	125.00	1.26	494.54	207.00	58.14	1814.32	302.00	83.35
50	1431 Monument Rd.	123.44	115.00	6.84	453.96	118.00	74.01	1586.30	531.00	66.53
51	1505 Monument Rd.	44.34	253.00	470.64	168.29	280.00	66.38	785.62	442.00	43.74
52	St. Johns Bluff Rd. & Monument Rd.	30.23	23.00	23.92	119.08	288.00	141.85	493.85	471.00	4.63
53	St. Johns Bluff Rd. & Causey Ln.	29.73	109.00	266.63	116.83	354.00	203.01	492.69	462.00	6.23
54	St. Johns Bluff Rd. & S. Akers Dr.	30.24	22.00	27.25	116.73	146.00	25.08	494.73	742.00	49.98
55	St. John's Bluff Rd. & Lone Star Rd.	30.40	48.00	57.91	117.77	260.00	120.76	515.93	536.00	3.89
56	850 St. Johns Bluff Rd.	30.55	238.00	679.04	117.94	296.00	150.98	563.46	430.00	23.69
57	St. Johns Bluff Rd. & Craig Industrial Dr.	30.11	31.00	2.96	117.50	96.00	18.30	597.66	515.00	13.83
58	St. Johns Bluff Rd. & Airport Terrace Dr.	30.46	22.00	27.78	118.36	48.00	59.44	637.95	1336.00	109.42
59	St. Johns Bluff Rd. & Atlantic Blvd.	34.81	139.00	299.35	147.05	812.00	452.20	686.48	1707.00	148.66
60	St. Johns Bluff Rd. & Theresa Dr.	51.23	73.00	42.51	196.64	865.00	339.90	730.84	1641.00	124.54
61	St. Johns Bluff Rd. & Bradley Rd.	53.24	90.00	69.03	197.41	122.00	38.20	752.05	342.00	54.52
62	St. Johns Bluff Rd. & Lost Pine Dr.	39.29	31.00	21.10	157.96	299.00	89.29	669.59	506.00	24.43
63	St. Johns Bluff Rd. & Fraser Rd.	39.16	313.00	699.22	155.62	350.00	124.91	713.75	558.00	21.82
64	St. Johns Bluff Rd. & Alden Rd.	44.05	14.00	68.22	191.49	210.00	9.67	802.62	661.00	17.65
65	2656 St. Johns Bluff Rd.	62.59	97.00	54.98	246.81	244.00	1.14	923.36	1678.00	81.73
66	St. Johns Bluff Rd. & Judicial Dr.	62.20	220.00	253.71	258.86	415.00	60.32	972.84	1509.00	55.11
67	St. Johns Bluff Rd. & Saints Rd.	63.14	310.00	390.98	260.75	525.00	101.34	1048.28	1635.00	55.97
68	St. Johns Bluff Rd. & Beach Blvd.	73.01	298.00	308.16	284.90	1251.00	339.10	1146.26	3064.00	167.30
69	Central Pkwy.& St. Johns Bluff Rd.	43.27	42.00	2.93	221.26	680.00	207.34	1062.56	2420.00	127.75
70	11655 Central Pkwy.	42.90	160.00	272.92	171.89	1705.00	891.91	759.86	3075.00	304.68
71	11710 Central Pkwy.	42.90	1416.00	3200.36	171.89	2185.00	1171.16	765.94	3568.00	365.83
72	11818 Central Pkwy.	42.90	430.00	902.23	183.03	2545.00	1290.52	869.23	3777.00	334.52
73	F.C.C.J. Southside Campus	91.03	0.00	100.00	345.46	3.00	99.13	1110.54	1288.00	15.98
74	Central Pkwy. & Beach Blvd.	82.64	253.00	206.15	300.67	899.00	198.99	1080.12	3651.00	238.02
75	Beach Blvd. & Central Pkwy.	62.62	362.00	478.06	259.35	914.00	252.42	986.80	3667.00	271.61
76	12000 Beach Blvd.	37.78	152.00	302.35	155.38	520.00	234.67	712.24	1275.00	79.01
77	Beach Blvd. & Sans Pareil St.	38.08	203.00	433.10	149.37	347.00	132.31	604.15	568.00	5.98
78	3694 Kernan Blvd.	42.90	33.00	23.08	190.12	49.00	74.23	849.27	269.00	68.33
79	Kernan Blvd. & Gehrig Dr.	42.90	10.00	76.69	171.89	10.00	94.18	753.80	65.00	91.38
80	Kernan Blvd. & Mantle Dr.	42.90	0.00	100.00	171.89	4.00	97.67	710.70	27.00	96.20

Table 9 Continued

No	Stop Name	Total Employment								
		Buffer 1 (1/8 th mile)			Buffer 2 (1/4 th mile)			Buffer 3 (1/2 th mile)		
		Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff	Aggregate level	Disaggregate level	Absolute % Diff
81	Kernan Blvd. & Hunter's Haven Ln.	42.90	4.00	90.68	171.89	6.00	96.51	688.18	78.00	88.67
82	Kernan Blvd. & Blue Stream Dr.	42.90	8.00	81.35	171.89	12.00	93.02	688.15	76.00	88.96
83	Kernan Blvd. & First Coast Technology Pkwy.	42.90	38.00	11.43	171.89	44.00	74.40	688.15	501.00	27.20
84	UNF Dr. & Alumni Dr.	42.90	0.00	100.00	171.89	55.00	68.00	688.15	515.00	25.16
85	U.N.F. Osprey Landing (U.N.F Dr.)	42.90	55.00	28.19	171.89	55.00	68.00	688.15	55.00	92.01
86	U.N.F. Library (U.N.F. Dr.)	42.90	0.00	100.00	171.89	0.00	100.00	717.82	55.00	92.34
87	U.N.F. Arena (U.N.F. Dr.)	42.90	0.00	100.00	171.89	0.00	100.00	688.15	0.00	100.00
88	Town Center & Brightman Bl	96.71	42.00	56.57	387.47	90.00	76.77	1551.21	1709.00	10.17
89	Town Crossing & Buckhead Branch	96.71	84.00	13.15	387.47	773.00	99.50	1551.21	2803.00	80.70
90	Town Center Mall	96.71	223.00	130.57	387.47	1735.00	347.77	1551.21	2786.00	79.60
	Average	297.65	609.28	**220.61**	1,132.28	2,318.31	**155.62**	3,959.75	5,735.97	**77.77**
	Standard Deviation	569.73	1173.30		2127.17	4710.90		6820.46	9228.99	

Figure 7 and 8 show graphs of aggregate and disaggregate level single family population and multi-family population captured within 1/8th mile, 1/4th mile and 1/2 mile stops buffer of route R5. The graphs show differences between aggregate and disaggregate population captured with each stop buffer. These differences between aggregate and disaggregate population can be clearly explained with the help of examples in figure 6. Figure 9 shows graphs of aggregate and disaggregate level total employment captured within 1/8th mile, 1/4th mile and 1/2 mile stops buffer of route R5. The results indicate that aggregate level total employment is less than disaggregate level total employment for most of the stops and for all sizes of the catchment area. Since high density of employment is observed along the route, the assumption of uniform spatial distribution of employment within each block group might be leading to the underestimation of employment at the aggregate level.

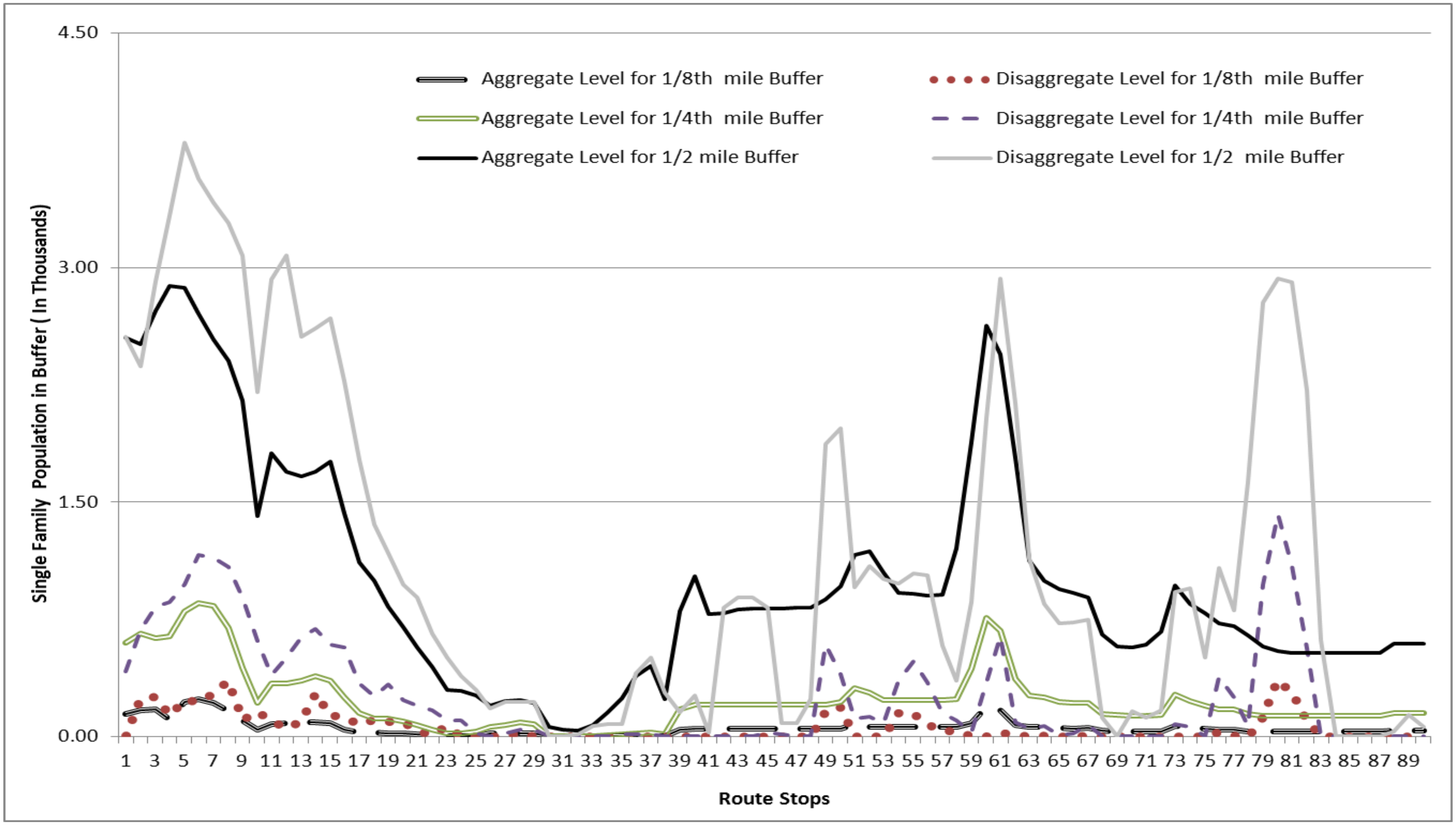


Figure 7 Graph Showing Aggregate and Disaggregate Level Single Family Population Computed Using Stop Level Analysis for Different Sizes of Catchment Area (Buffer) Around Route R5 Stops

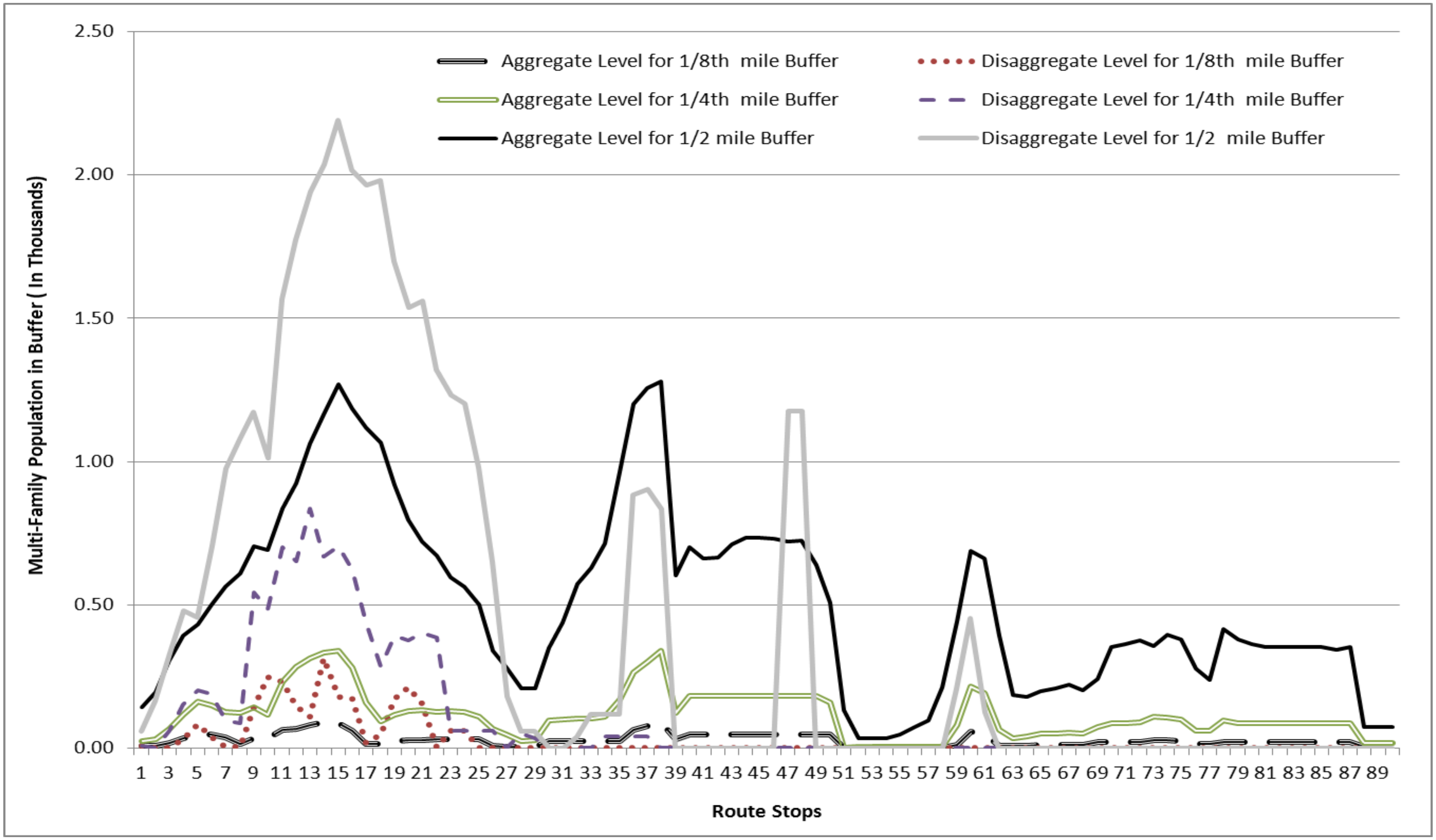


Figure 8 Graph Showing Aggregate and Disaggregate Level Multi-Family Population Computed Using Stop Level Analysis for Different Sizes of Catchment Area (Buffer) Around Route R5 Stops

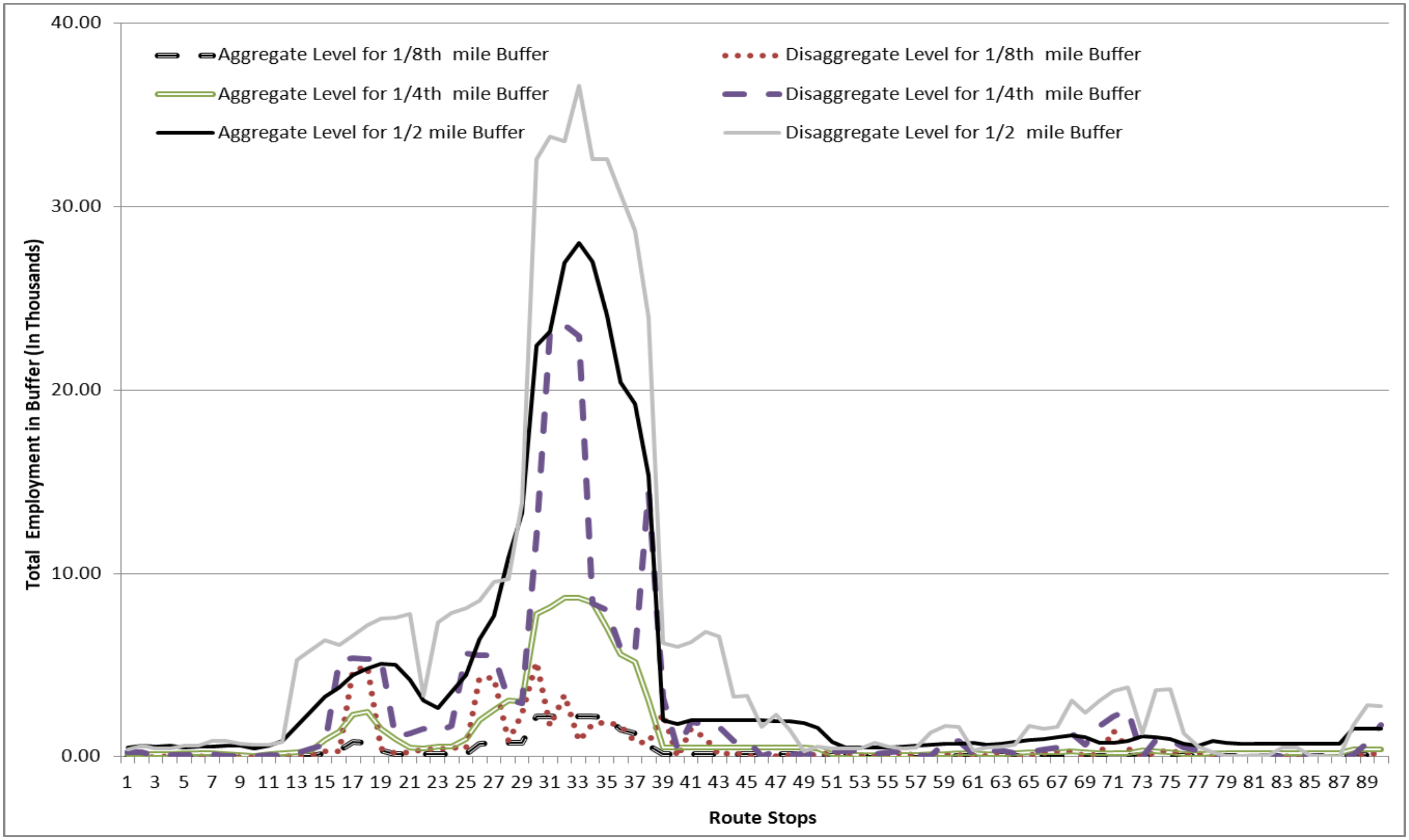


Figure 9 Graph Showing Aggregate and Disaggregate Level Total Employment Computed Using Stop Level Analysis for Different Sizes of Catchment Area (Buffer) Around Route R5 Stops

The percent differences between the aggregate and disaggregate level single family population, multi-family population and total employment for the stops of all four routes were also studied. This percent differences were classified into categorizes using the nested means classification technique[7]. Table 10, 11 and 12 presents the distribution of number of stops within each percentage difference category of single family population, multi-family population and total employment for different sizes of catchment area. In table 10, the percentage difference categories in negative range signify that the aggregate level single family population is higher than disaggregate level single family population. The category of "-100%" difference indicates that there is no single family population at disaggregate level. The category of "0%" difference indicates that there is no difference between aggregate level and disaggregate level single family population. The percentage difference categories in positive range signify that the disaggregate level single family population is higher than aggregate level single family population. Similarly, the categories in table 11 and 12 can be explained.

These tables help in understanding the variation in percentage difference between aggregate and disaggregate level single family population, multi-family population and total employment. It is observed that the number of stops having percentage difference in negative range decreases with the increase in buffer size of the transit stops. Also, number of stops having -100% differences in multi-family population are more as compared to single family population and total employment. As the multi-family parcels are few in number and are widely distributed, this variation can be explained.

[7] In Nested Means Classification, mathematical mean of the attribute values is calculated and the data is separated into two classes based on the mean. Data is further classified by calculating the means of the values within these two categories.

Table 10 Distribution of Number of Stops Within Each Percentage Difference Category of Single Family Population for Different Sizes of Catchment Area

Percentage Difference Categories (%)	Buffer 1 (1/8th mile)		Buffer 2 (1/4th mile)		Buffer 3 (1/2 mile)	
	Number of Stops	Percent Distribution (%)	Number of Stops	Percent Distribution (%)	Number of Stops	Percent Distribution (%)
-100	99	26.8	56	15.2	12	3.3
-76 to -99	25	6.8	18	4.9	12	3.3
-61 to -75	12	3.3	20	5.4	8	2.2
-41 to -60	18	4.9	19	5.1	11	3.0
-21 to -40	28	7.6	25	6.8	29	7.9
-11 to -20	11	3.0	20	5.4	12	3.3
-1 to -10	10	2.7	24	6.5	57	15.4
0	14	3.8	0	.0	0	.0
1 to 10	16	4.3	26	7.0	69	18.7
11 to 20	16	4.3	15	4.1	46	12.5
21 to 40	20	5.4	28	7.6	52	14.1
41 to 60	13	3.5	30	8.1	25	6.8
61 to 90	14	3.8	33	8.9	25	6.8
91 to 200	46	12.5	37	10.0	7	1.9
Greater than 200	27	7.3	18	4.9	4	1.1
Total	**369**	**100.0**	**369**	**100.0**	**369**	**100.0**

Table 11 Distribution of Number of Stops Within Each Percentage Difference Category of Multi-Family Population for Different Sizes of Catchment Area

Percentage Difference Categories (%)	Buffer 1 (1/8th mile)		Buffer 2 (1/4th mile)		Buffer 3 (1/2 mile)	
	Number of Stops	Percent Distribution (%)	Number of Stops	Percent Distribution	Number of Stops	Percent Distribution (%)
-100	235	63.7	162	43.9	96	26.0
-81 to -99	5	1.4	19	5.1	23	6.2
-61 to -80	4	1.1	20	5.4	14	3.8
-36 to -60	14	3.8	14	3.8	24	6.5
-1 to -35	6	1.6	13	3.5	54	14.6
0	18	4.9	15	4.1	1	.3
1 to 30	13	3.5	19	5.1	67	18.2
31 to 60	10	2.7	22	6.0	25	6.8
61 to 100	6	1.6	18	4.9	38	10.3
101 to 150	9	2.4	14	3.8	16	4.3
151 to 200	7	1.9	15	4.1	6	1.6
201 to 250	8	2.2	12	3.3	2	.5
Greater than 250	34	9.2	26	7.0	3	.8
Total	**369**	**100.0**	**369**	**100.0**	**369**	**100.0**

Table 12 Distribution of Number of Stops Within Each Percentage Difference Category of Total Employment for Different Sizes of Catchment Area

Percentage Difference Categories (%)	Buffer 1 (1/8th mile)		Buffer 2 (1/4th mile)		Buffer 3 (1/2 mile)	
	Number of Stops	Percent Distribution (%)	Number of Stops	Percent Distribution	Number of Stops	Percent Distribution (%)
-100	18	4.9	5	1.4	1	.3
-66 to -99	38	10.3	18	4.9	12	3.3
-41 to -65	24	6.5	21	5.7	27	7.3
-21 to -40	26	7.0	20	5.4	39	10.6
-1 to -20	5	1.4	23	6.2	46	12.5
1 to 20	27	7.3	39	10.6	68	18.4
21 to 40	35	9.5	35	9.5	60	16.3
41 to 55	20	5.4	35	9.5	32	8.7
56 to 85	37	10.0	44	11.9	35	9.5
86 to 130	42	11.4	45	12.2	21	5.7
131 to 200	21	5.7	34	9.2	16	4.3
201 to 300	22	6.0	26	7.0	10	2.7
Greater than 300	54	14.6	24	6.5	2	.5
Total	**369**	**100.0**	**369**	**100.0**	**369**	**100.0**

The KS (Kolmogorove-Smirnov) test[8] was performed to test if the population and employment obtained at both aggregate and disaggregate levels are statistically different. The KS test was carried out to test disaggregate and aggregate level single family population, multi-family population and total employment for different sizes of catchment area. The results showed a lower p-value of less than 0.05 resulting in rejection of the null hypothesis of no difference between aggregate and disaggregate level population and employment.

Linear regression analysis was also performed for each size of catchment area with total boarding at each stop as dependent variable and population and employment as independent variables. The results in table 13 show that disaggregate level population and employment have higher t-stats than aggregate level population and employment for 1/8th

[8] The Kolmogorov-Smirnov test (KS-test) is a non-parametric test which tries to determine if two datasets differ significantly.

mile, 1/4th mile and 1/2 mile of catchment area. This indicates that population and employment captured at disaggregate level explain transit ridership at each stop more accurately as compared to population and employment at aggregate level. Infact the regression results at aggregate level for 1/8th mile, 1/4th mile and 1/2 mile of catchment area indicates a negative (but statistically insignificant) effect of population on transit boardings. Such unusual results can be avoided by capturing the population at disaggregate level.

Table 13 Parameter Estimates (t-stats) of the Linear Regression Analysis Between Total Boarding, Population and Employment Within Each Stop Buffer

Independent Variable	Buffer 1 (1/8th mile)		Buffer 2 (1/4th mile)		Buffer 3 (1/2 mile)	
	Aggregate level	Disaggregate level	Aggregate level	Disaggregate level	Aggregate level	Disaggregate level
Constant	9.303 (2.20)	3.127(1.55)	8.712 (1.93)	6.468 (2.23)	5.550 (1.08)	3.939 (1.07)
Population in stop buffer	-0.056 (-0.57)	0.066 (0.98)	-0.033 (-0.33)	0.054 (0.57)	0.051(0.50)	0.121 (1.22)
Total Employment in stop buffer	0.496 (5.09)	0.794 (11.69)	0.480 (4.84)	0.538 (5.74)	0.436 (4.31)	0.468 (4.72)
R^2	0.27	0.61	0.24	0.53	0.18	0.21

4.2.2 Results of Route Level Analysis

This section describes the results of route level analysis based on the population (single family and multi-family) and employment obtained for each route for different sizes (1/8th mile, 1/4th mile and half mile) of catchment area at aggregate and disaggregate level. Figure 10 show graphs comparing aggregate and disaggregate level single family population and multi-family population for each route buffer. The graphs show large differences in the single family population and multi-family population obtained at both levels. Multi-family population seems to be more affected as compared to single family population for all sizes of catchment area. Figure 11 shows the plot of total employment captured at aggregate and disaggregate level for each route buffer. The graphs indicate that the total employment at the aggregate level is less than the total employment at the disaggregate level for different sizes of catchment area of all the transit routes. As discussed in the results of stop level analysis, assumption of uniform spatial distribution at aggregate level and concentration of employment along the transit route leads to this underestimation. The graphs also show that the differences in aggregate and disaggregate level single family population, multi-family population and total employment reduces as the size of the catchment area increases.

Table 14 presents the absolute percent difference between aggregate level and disaggregate level single family population, multi-family population and employment obtained for different sizes of catchment area (buffer). The results indicate that there is an average difference of about 20 % in aggregate level and disaggregate level single family population captured within 1/8th mile catchment area of a route. This average difference in single family population reduces to about 9 % and 5% as the catchment area of the transit route increases to quarter mile and half mile respectively. Similarly, the average absolute percent difference reduces for multi-family population and total employment as the size of the catchment area increases. The average absolute percent differences also indicate that the total employment is more affected as compared to population (Pascoe, 2007). These differences suggest the need of capturing the demographics at disaggregate level i.e. using parcel data in the catchment area of a transit service.

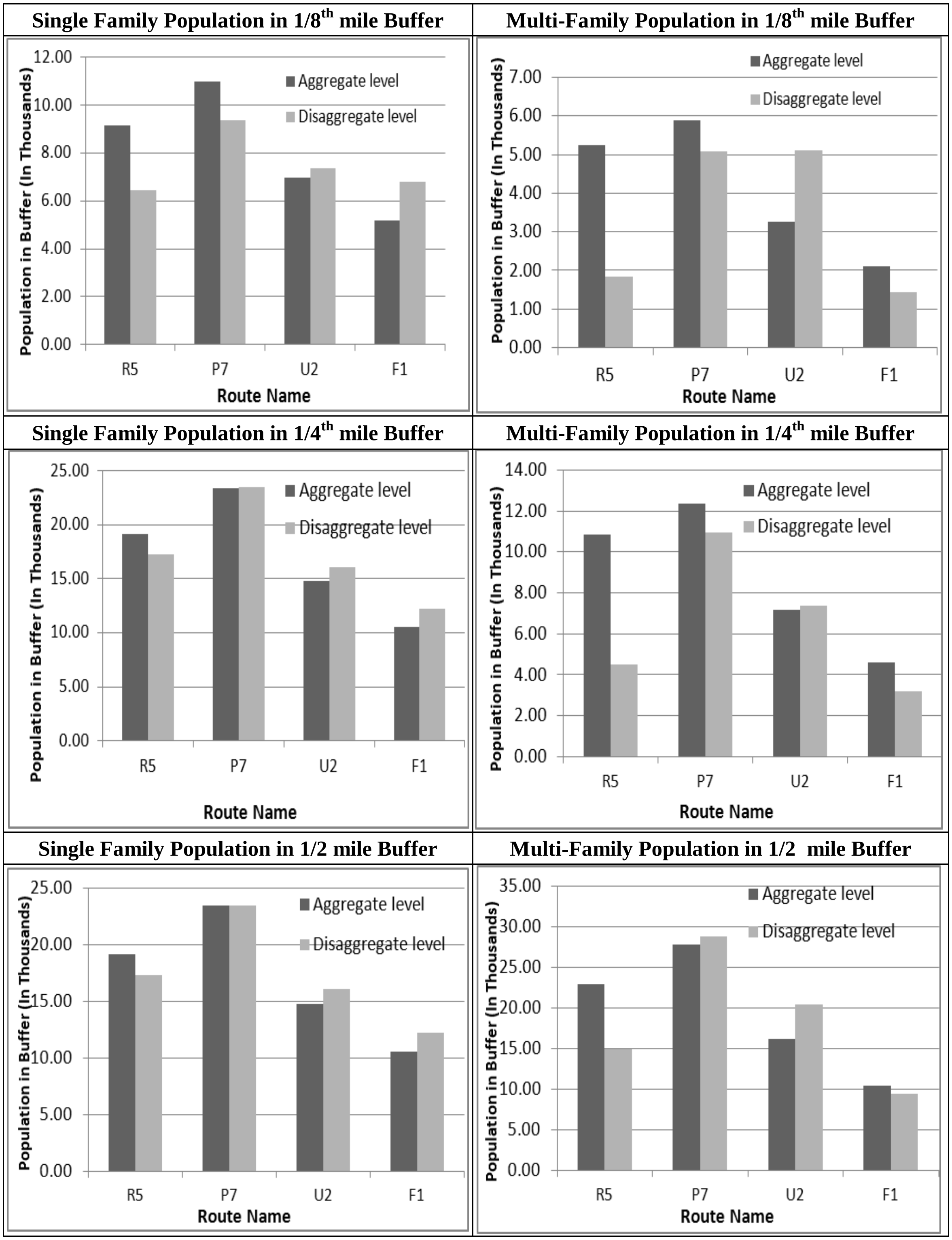
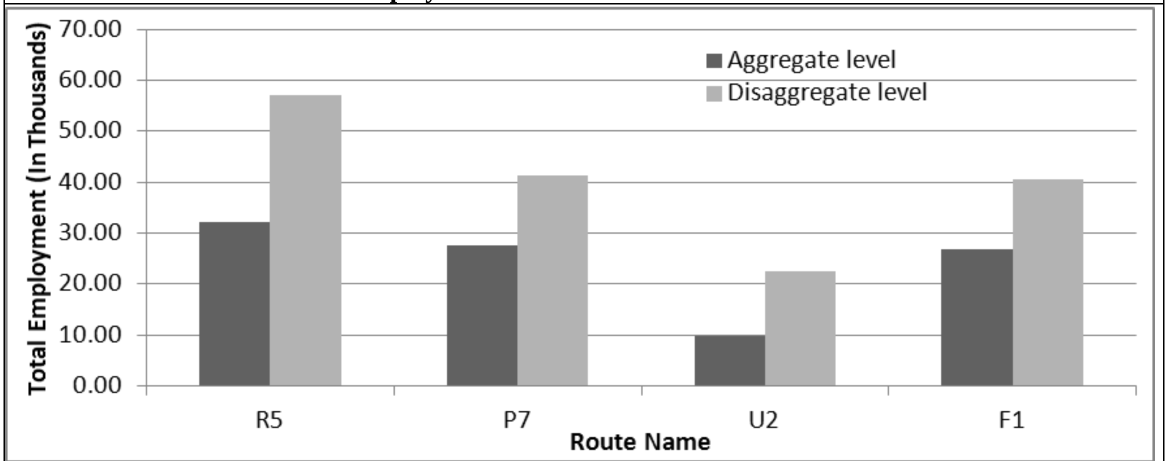
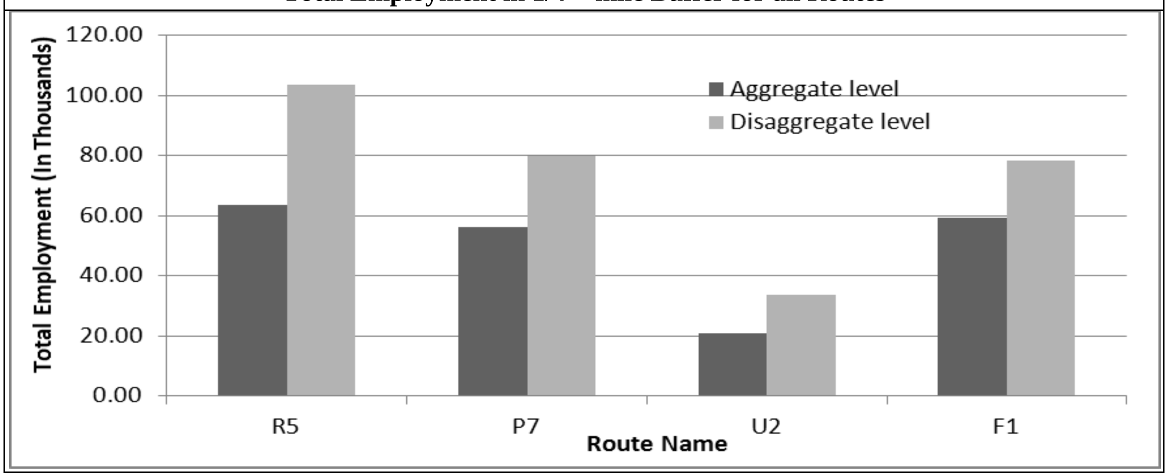


Figure 10 Graphs Showing Aggregate and Disaggregate Level Single Family and Multi-Family Population Computed Using Route Level Analysis for Different Sizes of Catchment Area (Buffer)

Total Employment in 1/8th mile Buffer for all Routes



Total Employment in 1/4th mile Buffer for all Routes



Total Employment in 1/2 mile Buffer for all Routes

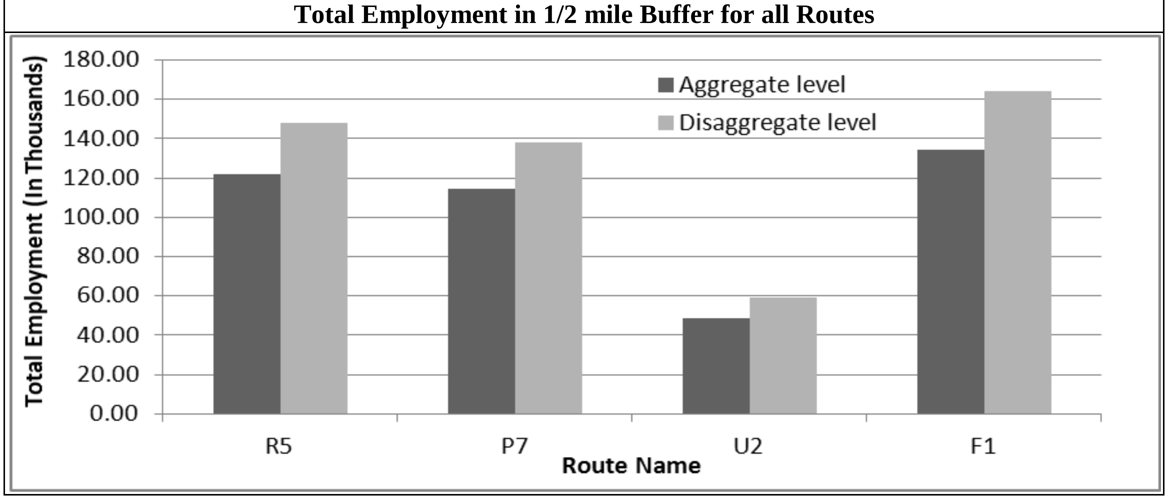


Figure 11 Graphs Showing Aggregate and Disaggregate Level Total Employment Computed Using Route Level Analysis for Different Sizes of Catchment Area (Buffer)

Table 14 Absolute Percentage Difference Between Aggregate Level and Disaggregate Level Single Family Population, Multi-Family Population and Employment Obtained Using Route Level Analysis for Different Sizes of Catchment Area (Buffer)

Route No	Route Description	Buffer 1 (1/8th mile)			Buffer 2 (1/4th mile)			Buffer 3 (1/2th mile)		
		Absolute Percent Difference in Single Family Population	Absolute Percent Difference in Multi Family Population	Absolute Percent Difference in Total Employment	Absolute Percent Difference in Single Family Population	Absolute Percent Difference in Multi Family Population	Absolute Percent Difference in Total Employment	Absolute Percent Difference in Single Family Population	Absolute Percent Difference in Multi Family Population	Absolute Percent Difference in Total Employment
R5	Murray Hill-Regency -FCCJ - UNF	29.73	65.21	78.46	9.65	58.69	62.95	0.04	35.07	21.17
P7	Dunn - FCCJ North/Normandy	14.68	13.67	49.04	0.17	11.46	42.14	4.02	3.47	20.27
U2	University Boulevard Connector	6.15	56.88	128.01	9.13	3.31	60.69	9.23	25.52	21.74
F1	Broadway - Detroit/Florida Ave	31.12	31.52	50.87	15.98	30.83	31.57	8.45	10.38	21.99
	Average	**20.42**	**41.82**	**76.59**	**8.73**	**26.07**	**49.34**	**5.43**	**18.61**	**21.29**

CHAPTER 5 TRIP ATTRACTION CAPABILITY ENHANCEMENT

This chapter discusses the possibilities which were explored to improve the trip attraction capabilities of the TBEST model.

5.1 Employment Based Trip Attraction

This section discusses the strategy used to refine employment data for accurately capturing the trip attraction from non-residential land uses. The strategy used aims at taking into account the trips due to employment by developing the trip attraction per employment type. Table 15 shows the trips attraction per employee for each type of employment and each TBEST time period. The values used in table 15 reflect project team judgment and knowledge of travel behavior and are not empirically derived. These values will be applied to the InfoUSA employment categories for each non-residential land use (DOR land use code greater than 10) shown in table 2.

Table 15 Trips Attraction per Employee for Each Type of Employment and Each TBEST Time Period

Trip Attractions/Productions Assigned per Employee			
	Industrial	**Commercial**	**Service**
Am Peak	.5	.4	.5
Midday	.1	.2	.2
Pm Peak	.5	.4	.5
Evening	.3	.2	.2
Saturday	.1	.2	.2
Sunday	.1	.2	.2
Total			

5.2 Development of Parcel Land Use Based Trip Attraction/Production

In addition to using the employment based trip attraction noted above, TBEST can also be enhanced by adding information about parcel land use. The study aims at improving the predictive capability of the TBEST model by developing parcel land use based trip attraction (instead of employment) using the ITE trip generation manual and the NHTS 2001 database.

The non-residential land use categories (DOR land use code greater than 10) in the parcel data (shown in table 2) were used as a foundation to develop a strategy to match parcel land use classification with ITE land uses. Table 16 gives the trip rates of parcel level land use for TBEST time periods using ITE's trip generation manual and the NHTS 2001 database. The first part of the table with the heading "TRIP RATE FROM ITE TRIP GENERATION MANUAL" gives the trip rate for each land use using the ITE trip generation manual, 8th Edition. In this manual most of the trip rates are available for one or more of: (1) a weekday, (2) weekday AM peak one-hour, (3) weekday PM peak one-hour, (4) Saturday, and (5) Sunday. The methodology used to obtain trip rates for each parcel land use category is as follows:

1) The trip rates were obtained by matching each land use category with the closest available ITE land use category (one to one mapping).
2) Several parcel-level land-use codes include multiple ITE land-use categories under one single (parcel-level) land-use code. In such cases of a one-to-many correspondence from parcel-level land-use codes to ITE land-use categories, the ITE trip generation rates were averaged across the land-uses. For example, florists

and green houses are included within a single parcel-level land use code (030)[9]. The trip rate for this land-use code was obtained by taking an average of the ITE trip rate for florists and the ITE trip rate for greenhouses. Same strategy has been used for several other land-use categories such as motels and hotels (039), and auto sales and auto parts (027).

3) Under some parcel-level land-use codes, however, rather disparate types of land-uses are clubbed. For example, airports, marinas, and other water terminals were classified into a single parcel-level land-use code (020). These land-uses are significantly different from each other in terms of their trip generation characteristics. In such cases, the table provides separate trip rates for each of the land-uses.

4) For parcel level land-use codes such as restaurants and parks which are classified into many types in the ITE trip generation manual (i.e., a many-to-one correspondence), the maximum value of the trip rates of the different ITE land-uses is reported. For example, ITE trip rates are available for two types of restaurants (021) – high-quality restaurants and high-turnover restaurants. The trip rate of high-turnover restaurants (which is higher than that of the high-quality restaurants) is reported in this case.

5) Several parcel level land-use categories do not have trip rates available by square footage in the in ITE trip generation manual. For example, the airports category (020) does not have trip rates per square footage. Therefore, trip rates for such land use categories are given with respect to other variables available in the ITE Trip generation manual. Other land-uses such as service stations (026), race tracks

[9] Numbers in parentheses show the parcel-level land use code

(037), golf courses (038), hotels & motels (039), homes for the aged (074) and military base (081) have the same issue.

6) If the trip rate is not available for a particular time period, it is marked as NA – Not Available in the cell corresponding to that land use and time period.

Table 16 Trip Rates of Parcel Level Land Use for TBEST Time Periods Using ITE Trip Generation Manual and NHTS 2001 Database

DOR code	PROPERTY TYPE	TRIP RATE FROM ITE TRIP GENERATION MANUAL						TRIP RATE BASED ON ITE TRIP MANUAL AND NHTS 2001 DATABASE FOR TBEST TIME PERIODS									
								Weekday AM Peak Period		Weekday PM Peak Period		Week day Off-Peak Period		Week day Night Period			
Commercial		Unit (Independent Variable)	Week day	Week day AM Peak Hour	Week day PM Peak Hour	Satur day	Sun day	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Satur day	Sun day
10	Vacant Commercial																
11	Stores, one story	1000 Sq.ft GFA	22.88	2.14	2.81	25.4	NA	3.85	4.37	5.67	8.15	8.10	6.27	5.29	4.09	25.40	**4.54**
12	Mixed use - store and office or store and residential or residential combination	1000 Sq.ft GFA	17.225	1.97	2.27	NA	NA	2.90	4.02	4.27	6.58	6.10	4.01	3.98	2.61	**3.05**	**3.42**
13	Department Stores	1000 Sq.ft GFA	22.88	2.14	2.81	25.4	NA	3.85	4.37	5.67	8.15	8.10	6.27	5.29	4.09	25.4	**4.54**
14	Supermarkets	1000 Sq.ft GFA	102.24	10.05	11.85	177.59	166.44	17.19	20.53	25.36	34.37	36.19	28.66	23.62	18.69	177.59	166.44
15	Regional Shopping Centers	1000 Sq.ft GFA	42.94	1	3.73	49.97	25.24	7.22	2.04	10.65	10.82	15.20	18.21	9.92	11.87	49.97	25.24
16	Community Shopping Centers	1000 Sq.ft GFA	42.94	1	3.73	49.97	25.24	7.22	2.04	10.65	10.82	15.20	18.21	9.92	11.87	49.97	25.24
17	Office buildings, non-professional service buildings, one story	1000 Sq.ft GFA	11.57	1.8	1.73	NA	NA	1.94	3.68	2.87	5.02	4.10	1.74	2.67	1.13	**2.05**	**2.30**
18	Office buildings, non-professional service buildings, multi-story	1000 Sq.ft GFA	23.14	3.6	3.46	NA	NA	3.89	7.35	5.74	10.03	8.19	3.48	5.35	2.27	**4.10**	**4.59**
19	Professional service buildings	1000 Sq.ft GFA	11.01	1.55	1.49	2.37	0.98	1.85	3.17	2.73	4.32	3.90	2.13	2.54	1.39	2.37	0.98
20	Airports	Employees	13.4	1.21	1	12.2	14.7	2.25	2.47	3.32	2.90	4.74	4.86	3.10	5.29	12.2	14.7
	Marine terminals, piers, marinas	1000 Sq.ft	0.48	NA	NA	0.57	0.79	0.08	NA	0.12	NA	0.17	NA	0.11	NA	0.57	0.79
21	Restaurants, cafeterias	1000 Sq.ft GFA	127.15	13.53	18.49	158.37	131.84	21.37	27.64	31.53	53.62	45.01	27.78	29.37	18.11	158.37	131.84
22	Drive-in Restaurants	1000 Sq.ft GFA	496.12	54.81	46.14	722.03	542.72	83.40	111.98	123.04	133.81	175.63	151.53	114.60	98.81	722.03	542.72
23	Financial institutions	1000 Sq.ft GFA	148.15	17.31	26.69	86.32	31.9	24.90	35.36	36.74	77.40	52.45	21.42	34.22	13.97	86.32	31.9
24	Insurance company offices																
25	Repair service shops (excluding automotive)	1000 Sq.ft GFA	44.32	6.84	5.02	42.04	26.43	7.45	13.97	10.99	14.56	15.69	9.56	10.24	6.23	42.04	26.43

Table 16 Continued

DOR code	PROPERTY TYPE	TRIP RATE FROM ITE TRIP GENERATION MANUAL						TRIP RATE BASED ON ITE TRIP MANUAL AND NHTS 2001 DATABASE FOR TBEST TIME PERIODS									
								Weekday AM Peak Period		Weekday PM Peak Period		Week day Off- Peak Period		Week day Night Period			
Commercial		Unit (Independent Variable)	Week day	Week day AM Peak Hour	Week day PM Peak Hour	Satur day	Sun day	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Satur day	Sun day
26	Service stations	Vehicle Fueling Positions	168.56	12.58	15.65	NA	NA	28.33	25.70	41.80	45.39	59.67	59.00	38.94	38.47	**29.87**	**33.44**
27	Auto sales, auto repair and storage	1000 Sq.ft GFA	47.625	3.31	4.61	21.03	10.48	8.01	6.76	11.81	13.37	16.86	16.64	11.00	10.85	21.03	10.48
	Auto service shops, commercial garages.	1000 Sq.ft GLA	NA	3.22	4.01	15.86	2.59	**2.19**	6.58	**3.23**	11.63	**4.62**	NA	**3.01**	NA	15.86	2.59
28	Parking lots (commercial or patron) mobile home parks	1000 Sq.ft	0. 91	0.08	0.105	0.83	0.74	0.15	0.16	0.23	0.30	0.32	0.27	0.21	0.17	0.83	0.74
29	Wholesale , manufacturing outlets, produce houses,	1000 Sq.ft GFA	6.73	0.58	0.52	1.59	2.3	1.13	1.18	1.67	1.51	2.38	2.44	1.55	1.59	1.59	2.3
30	Florist, greenhouses	1000 Sq.ft	40.2	5.63	4.99	57.38	39.45	6.76	11.50	9.97	14.47	14.23	8.61	9.29	5.62	57.38	39.45
31	Drive-in theaters, open stadiums	1000 Sq.ft	0.765	NA	NA	NA	NA	0.13	NA	0.19	NA	0.27	NA	0.18	NA	**0.14**	**0.15**
32	Enclosed theaters, enclosed auditoriums	1000 Sq.ft GFA	NA	NA	26.7	99.28	81.9	**n/a**[10]	**n/a**	NA	77.43	NA	**110.64**	NA	**72.10**	99.28	81.9
33	Nightclubs, cocktail lounges, bars	1000 Sq.ft GFA	NA	NA	15.49	NA	NA	**n/a**	**n/a**	NA	44.92	**n/a**	**n/a**	**NA**	**41.83**	**32.14**	**35.99**
34	Bowling alleys, pool halls	1000 Sq.ft GFA	33.33	3.13	3.54	NA	NA	5.60	6.39	8.27	10.27	11.80	10.09	7.70	6.58	**5.91**	**6.61**
	Enclosed arenas	1000 Sq.ft	0.765	NA	NA	NA	NA	0.13	NA	0.19	NA	0.27		0.18		**0.14**	**0.15**
	Skating rinks	1000 Sq.ft GFA	NA	NA	2.36	NA	NA	**4.65**	NA	NA	6.84	**9.78**	**9.78**	**6.37**	**6.37**	**4.90**	**5.48**
35	Tourist attractions, permanent exhibits	1000 Sq.ft	2.075	0.066	0.265	2.24	1.871	0.35	0.13	0.51	0.77	0.73	0.71	0.48	0.46	2.24	1.87
36	Camps	1000 Sq.ft	NA	0.012	0.024	NA	NA	NA	0.02	NA	0.07	**0.10**	**0.10**	**0.06**	**0.06**	**0.05**	**0.06**
37	Race tracks; horse	1000 Sq.ft	0.987	NA	NA	NA	NA	0.17	NA	0.25	NA	0.35	NA	0.23	NA	**0.17**	**0.20**
	Race tracks; Auto	Attendees	NA	NA	NA	0.28	NA										
	Race tracks; Dog	Attendees	NA	NA	0.41	NA	NA										
38	Golf courses, driving ranges	Employees	55.57	4.14	6.71	72	58.29	9.34	8.46	13.78	19.46	19.67	16.74	12.84	10.91	72	58.29
39	Hotels, motels	Employees	42.74	1.16	1.24	12.4	10.37	7.18	2.37	10.60	3.60	15.13	22.26	9.87	14.51	12.4	10.37

[10] n/a (not applicable) is equivalent to a zero trip rate.

Table 16 Continued

DOR code	PROPERTY TYPE	TRIP RATE FROM ITE TRIP GENERATION MANUAL						TRIP RATE BASED ON ITE TRIP MANUAL AND NHTS 2001 DATABASE FOR TBEST TIME PERIODS									
								Weekday AM Peak Period		Weekday PM Peak Period		Week day Off-Peak Period		Week day Night Period			
Industrial		Unit (Independent Variable)	Week day	Week day AM Peak Hour	Week day PM Peak Hour	Saturday	Sun day	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Satur day	Sun day
40	Vacant Industrial																
41	Light manufacturing, small equipment manufacturing plants, small machine shops, instrument manufacturing printing plants	1000 Sq.ft GFA	6.97	1.01	1.08	1.32	0.68	1.17	2.06	1.73	3.13	2.47	1.07	1.61	0.70	1.32	0.68
42	Heavy industrial, heavy equipment manufacturing, large machine shops, foundries, steel fabricating plants, auto or aircraft plants	1000 Sq.ft GFA	1.5	0.69	0.68	NA	NA	0.25	1.41	0.37	1.97	0.53	NA	0.35	NA	**0.27**	**0.30**
43	Lumber yards, sawmills, planing mills	1000 Sq.ft GFA	1.5	0.69	0.68	NA	NA	0.25	1.41	0.37	1.97	0.53	NA	0.35	NA	0.27	0.30
44	Packing plants, fruit and vegetable packing plants, meat packing plants.[1]	1000 Sq.ft GFA	3.82	0.78	0.75	1.49	0.62	0.64	1.59	0.95	2.18	1.35	0.03	0.88	0.02	1.49	0.62
45	Canneries, fruit and vegetable, bottlers and brewers distilleries, wineries.[1]	1000 Sq.ft GFA	3.82	0.78	0.75	1.49	0.62	0.64	1.59	0.95	2.18	1.35	0.03	0.88	0.02	1.49	0.62
46	Other food processing, candy factories, bakeries, potato chip factories.[1]	1000 Sq.ft GFA	3.82	0.78	0.75	1.49	0.62	0.64	1.59	0.95	2.18	1.35	0.03	0.88	0.02	1.49	0.62
47	Mineral processing, phosphate processing, cement plants, refineries, clay plants, rock and gravel plants.[11]	1000 Sq.ft GFA	3.82	0.78	0.75	1.49	0.62	0.64	1.59	0.95	2.18	1.35	0.03	0.88	0.02	1.49	0.62
48	Warehousing, distribution terminals, trucking terminals, van & storage warehousing	1000 Sq.ft GFA	3.56	0.42	0.45	1.23	0.78	0.60	0.86	0.88	1.31	1.26	0.85	0.82	0.55	1.23	0.78

[11] Manufacturing facilities are areas where the primary activity is the conversion of raw materials or parts into finished products.

Table 16 Continued

DOR code	PROPERTY TYPE	TRIP RATE FROM ITE TRIP GENERATION MANUAL						TRIP RATE BASED ON ITE TRIP MANUAL AND NHTS 2001 DATABASE FOR TBEST TIME PERIODS									
								Weekday AM Peak Period		Weekday PM Peak Period		Week day Off-Peak Period		Week day Night Period			
Agricultural		Unit (Independent Variable)	Week day	Week day AM Peak Hour	Week day PM Peak Hour	Satur day	Sun day	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Satur day	Sun day
50	Improved agricultural																
51	Cropland soil capability Class I																
52	Cropland soil capability Class II	1000 Sq.ft GFA	6.97	1.01	1.08	1.32	0.68	1.17	2.06	1.73	3.13	2.47	1.07	1.61	0.70	1.32	0.68
53	Cropland soil capability Class III																
54-58	Timberland - site index 50 and above							n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
59	Timberland not classified by site index to Pines	We assume zero trip rates here. If any, the trip rates for these land-uses can be expected to be rather small.						n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
60-65	Grazing land soil capability Class I to Class VI							n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
66	Orchard Groves, Citrus, etc.	1000 Sq.ft GFA	6.97	1.01	1.08	1.32	0.68	1.17	2.06	1.73	3.13	2.47	1.07	1.61	0.70	1.32	0.68
67	Poultry, bees, tropical fish, rabbits, etc.	1000 Sq.ft GFA	6.97	1.01	1.08	1.32	0.68	1.17	2.06	1.73	3.13	2.47	1.07	1.61	0.70	1.32	0.68
68	Dairies, feed lots	1000 Sq.ft GFA	6.97	1.01	1.08	1.32	0.68	1.17	2.06	1.73	3.13	2.47	1.07	1.61	0.70	1.32	0.68
69	Ornamentals, miscellaneous agricultural	1000 Sq.ft GFA	6.97	1.01	1.08	1.32	0.68	1.17	2.06	1.73	3.13	2.47	1.07	1.61	0.70	1.32	0.68

Table 16 Continued

DOR code	PROPERTY TYPE	TRIP RATE FROM ITE TRIP GENERATION MANUAL						TRIP RATE BASED ON ITE TRIP MANUAL AND NHTS 2001 DATABASE FOR TBEST TIME PERIODS									
								Weekday AM Peak Period		Weekday PM Peak Period		Week day Off-Peak Period		Week day Night Period			
Institutional		Unit (Independent Variable)	Week day	Week day AM Peak Hour	Week day PM Peak Hour	Saturday	Sunday	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Using temporal distribution of trips in NHTS	Using Peak Factors	Saturday	Sun day
70	Vacant																
71	Churches	1000 Sq.ft GFA	9.11	0.87	0.94	10.37	36.63	1.53	1.78	2.27	2.73	3.22	2.79	2.10	1.82	10.37	36.63
72 73	Private schools and colleges	1000 Sq.ft GFA	NA	NA	5.5	NA	NA	**10.83**	NA	NA	15.95	**NA**	**22.79**	NA	**14.85**	**11.41**	**12.78**
74	Privately owned hospitals	1000 Sq.ft GFA	16.5	1.25	1.46	10.18	8.91	2.77	2.55	4.09	4.23	5.84	5.88	3.81	3.83	10.18	8.91
74	Homes for the aged	Dwelling Units	3.71	0.29	0.34	2.77	2.33	0.62	0.59	0.92	0.99	1.31	1.29	0.86	0.84	2.77	2.33
75	Orphanages, other non-profit or charitable services[12]	1000 Sq.ft GFA	28.6	NA	NA	NA	NA	4.81	NA	7.09	NA	10.12	NA	6.61	NA	**5.07**	**5.67**
76	Mortuaries, cemeteries, crematoriums	1000 Sq.ft	0.108	0.017	0.037	0.136	0.175	0.02	0.03	0.03	0.11	0.04	0.00	0.02	0.00	0.136	0.175
77	Clubs	1000 Sq.ft GFA	43	3.19	5.84	38.46	36.77	7.23	6.52	10.66	16.94	15.22	11.83	9.93	7.72	38.46	36.77
	Lodges, union halls	Employees	46.9	4.3	4.05	29.55	29.1	7.88	8.78	11.63	11.75	16.60	15.96	10.83	10.41	29.55	29.1
78	Sanitariums, convalescent and rest homes	1000 Sq.ft GFA	7.58	0.42	0.72	NA	NA	1.27	0.86	1.88	2.09	2.68	2.80	1.75	1.83	**1.34**	**1.50**
79	Cultural organizations, facilities[13]	1000 Sq.ft GFA	68	NA	NA	NA	NA	11.43	NA	16.86	NA	24.07	NA	15.71	NA	**12.05**	**13.49**

[12] San Francisco Interim Transportation Impact Analysis Guidelines for Environmental Review, Interim Edition, January 2000, The Planning Department City and County of San Francisco.

[13] Study on Jewish Cultural Center 2000

Table 16 Continued

DOR code	PROPERTY TYPE	TRIP RATE FROM ITE TRIP GENERATION MANUAL						TRIP RATE BASED ON ITE TRIP MANUAL AND NHTS 2001 DATABASE FOR TBEST TIME PERIODS									
								Weekday AM Peak Period		Weekday PM Peak Period		Week day Off-Peak Period		Week day Night Period			
Government		**Unit (Independent Variable)**	**Week day**	**Week day AM Peak Hour**	**Week day PM Peak Hour**	**Satu rday**	**Sunday**	**Using temporal distributio n of trips in NHTS**	**Using Peak Factor s**	**Using temporal distributi on of trips in NHTS**	**Using Peak Factor s**	**Using temporal distributi on of trips in NHTS**	**Using Peak Factor s**	**Using temporal distributio n of trips in NHTS**	**Using Peak Factor s**	**Satu rday**	**Sunday**
80	Undefined - Reserved for future use																
81	Military	Employee	1.78	0.37	0.37	2.64	1.67	0.30	0.76	0.44	1.07	0.63	0.00	0.41	0.00	2.64	1.67
82	Forest	1000 Sq.ft	2.64	NA	NA	NA	NA	0.44	NA	0.65	NA	0.93	NA	0.61	NA	**0.47**	**0.52**
	Parks, recreational areas	1000 Sq.ft	NA	NA	NA	4.14	NA	**3.93**	NA	**5.79**	NA	**8.27**	NA	**5.39**	**NA**	4.14	**4.64**
83	Public county schools - include all property of Board of Public Instruction	1000 Sq.ft GFA	12.89	3.06	2.12	4.37	1.79	2.17	6.25	3.20	6.15	4.56	0.30	2.98	0.19	4.37	1.79
84	Colleges	1000 Sq.ft GFA	27.49	3.09	2.64	11.23	1.21	4.62	6.31	6.82	7.66	9.73	8.18	6.35	5.34	11.23	1.21
85	Hospitals	1000 Sq.ft GFA	16.5	1.25	1.46	10.18	8.91	2.77	2.55	4.09	4.23	5.84	5.88	3.81	3.83	10.18	8.91
86	Counties (other than public schools, colleges, hospitals) including non-municipal government.	1000 Sq.ft GFA	27.92	2.21	2.85	NA	NA	4.69	4.52	6.92	8.27	9.88	9.16	6.45	5.98	**4.95**	**n/a**
87	State, other than military, forests, parks, recreational areas, colleges, hospitals[14]	1000 Sq.ft GFA	27.92	2.21	2.85	NA	NA	4.69	4.52	6.92	8.27	9.88	9.16	6.45	5.98	**4.95**	**n/a**
88	Federal, other than military, forests, parks, recreational areas, hospitals, colleges[15]	1000 Sq.ft GFA	27.92	2.21	2.85	NA	NA	4.69	4.52	6.92	8.27	9.88	9.16	6.45	5.98	**4.95**	**n/a**
89	Municipal, other than parks, recreational areas, colleges, hospitals	1000 Sq.ft GFA	27.92	2.21	2.85	NA	NA	4.69	4.52	6.92	8.27	9.88	9.16	6.45	5.98	**4.95**	**n/a**
91	Utility, gas and electricity, telephone and telegraph, locally assessed railroads, water and sewer service, pipelines, canals, radio television communication	1000 Sq.ft GFA	NA	0.8	0.76	NA	NA	NA	1.63	NA	2.20	**NA**	**3.15**	**NA**	**2.05**	**1.58**	**1.77**

[14] Motor vehicle department office is an exception with 166.02 trips per 1000 Sq.ft GFA for weekday.
[15] Postal office is an exception with 108.19 trips per 1000 Sq.ft GFA for weekday.

As the ITE trip generation manual does not provide the trip rates for TBEST time periods (shown in Table 3), NHTS 2001 database along with ITE trip generation manual was used to obtain trip rates for TBEST time periods. The other part of the table 16 with the heading "TRIP RATE BASED ON ITE TRIP MANUAL AND NHTS 2001 DATABASE FOR TBEST TIME PERIODS" gives the trip rate of each land use for all the TBEST time periods. The methodology used to obtain trip rates for each TBEST time period is as follows:

1) In this part of table, the columns "Weekday AM Peak Period" and "Weekday PM Peak Period" are in turn split into two columns each – "Using temporal distribution of trips in NHTS" and "using Peak Factors[16]". The trip rates in these two columns have been computed using two different methods:

   Method 1: By multiplying the weekday trip rate obtained from ITE manual to the temporal distributions of weekday trips in the NHTS 2001 database shown in the table 17.

   Table 17 Temporal Distribution of Weekday Trips in 2001 NHTS Data

Period No.	Weekday Time period	Percent
1	6am to 8:59 am (AM peak period)	**16.8**
2	9:00 am to 2:59 pm (Off-peak period)	**35.4**
3	3:00 pm to 5:59 pm (PM peak period)	**24.8**
4	6:00 pm to 5:59 am (Night period)	**23.1**

   Method 2: By multiplying the peak one-hour trip rate from the ITE trip generation manual to the peak factor obtained from the NHTS 2001 database.

[16] This peak factor was computed by taking the ratio of the number of trips in the peak period to number of trips in the peak one-hour of the am or pm peak period.

From the two methods mentioned above, trip rates obtained using peak factor (Method 2) should be used because this methodology is more specific to the various land uses as compared to using the temporal distribution of NHTS 2001 database. But some of the parcel land-uses mentioned below have peak hour periods different from the TBEST time periods Table 18 shows the parcel land uses which have peak hour period different from TBEST time period.

Table 18 Parcel Land Uses Having Peak Hour Period Different from TBEST Time Period

DOR land-use code	Property Type	Peak Hour Period
12	Departmental Stores	AM Peak Period = 11:00 a.m. to 12:00 p.m. PM Peak Period = 12:30 p.m. to 5:00 p.m.
20	Airports	AM Peak Period = 11:00 a.m. to 12:00 p.m. PM Peak Period = 5:00 p.m. to 7:00 p.m.
23	Bank	AM Peak Period = 8:00 a.m. to 12:00 p.m. PM Peak Period = 12:00 p.m. to 6:00 p.m.
71	Church	AM Peak Period = 10:00 a.m. to 12:00 p.m. PM Peak Period = 7:00 p.m. to 11:00 p.m.
72	Private Schools	PM Peak Period = 2:30 p.m. to 4:00 p.m.
73 & 85	Hospitals	AM Peak Period = 8:00 a.m. to 10:00 a.m. PM Peak Period = 1:00 p.m. to 5:00 p.m.
77	Lodges	AM Peak Period = 11:00 a.m. to 12:00 p.m. PM Peak Period = 3:00 p.m. to 4:00 p.m.
83	Public County Schools	PM Peak Period = 2:00 p.m. to 4:00 p.m.

For the above mentioned land uses, it is better to use the trip rates obtained from the temporal distribution of trips in NHTS 2001 database.

2) The columns “Weekday Off-Peak Period” and “Weekday Night Period” in the table 16 are also split into following two columns – “Using temporal distribution of trips in NHTS” and “using Peak Factors”. The trip rates in these two columns have been computed using two different methods:

Method 1: By multiplying the weekday trip rate obtained from ITE manual to the above mentioned temporal distributions of weekday trips in the NHTS 2001 database (shown in table 17).

Method 2: By subtracting the sum of weekday AM peak and PM peak trip rates obtained using peak factors from the weekday trip rates and then multiplying this difference with the percentage distribution between weekday off-peak period and weekday night period obtained from the NHTS 2001 database.

3) For some land uses such as service stations (26)[17], night clubs (33), skating rinks, bowling alleys (34), race tracks (37), heavy industries (42), Private schools (72), trip rates for Saturday and Sunday are not available in ITE trip generation manual. The trip rates for Saturday and Sunday (highlighted as bold figures in table 16) are obtained using the distributions of trips in NHTS 2001 database shown in Table 19.

Table 19 Temporal Distribution of Trips in 2001 NHTS Data

Period No.	**Time Period**	**% Distribution**
1	AM peak period (6am to 8:59 am)	**12.22**
2	Off-peak period (9:00 am to 2:59 pm)	**25.72**
3	PM peak period (3:00 pm to 5:59 pm)	**18.00**
4	Night period (6:00 pm to 5:59 am)	**16.76**
5	Saturday (12 midnight - 11:59 PM)	**12.88**
6	Sunday (12 midnight - 11:59 PM)	**14.42**
		100.00

For some land-uses the weekday trip rate is also not available in the ITE trip generation manual. For such land uses, the distribution table above can be used to obtain the trip rates of the weekday time periods.

[17] Numbers in parentheses show the parcel-level land use code

4) For land uses such as theatres (32) which generally open only after 9 am, trip rate for weekday morning peak period is marked as n/a – not applicable[18]. Similarly, for land uses such as nightclubs and bars (33) which generally operate in the evening hours, the trip rates for weekday morning peak and weekday off-peak periods are marked as n/a.

5) Since the trip rates for orphanages, other charitable services (75), and for cultural organizations (79) are not available in the ITE trip generation manual, we used the following source: San Francisco Interim Transportation Impact Analysis Guidelines for Environmental Review, Interim Edition, January 2000, The Planning Department City and County of San Francisco.

These trip rates can be used to capture the activity levels at each land use. But these trip rates should be used with caution as they are vehicle trip rates and do not completely represent transit trip making.

[18] Please note that n/a (not applicable) is equivalent to a zero trip rate and this is different from NA (not available)

5.3 Special Generator Enhancement

This chapter is focused on improving the predictive capability of the TBEST model by exploring a better way to treat special generators rather than by just using it as a dummy variable in the model. Special generators are defined as land uses that do not generate or attract trips at the same rate as other land uses. To explore different ways of treating special generators, it is very important to understand how various regional travel demand models and transit analysis studies deal with special generators. Section 5.3.1 discusses how previous studies deal with special generators.

5.3.1 Literature Review

To explore a better way to treat special generators, various regional travel demand models and transit analysis studies dealing with special generators were reviewed. A considerable exploration of various regional travel demand models reveal the following ways in which special generators are dealt with in the literature:

1) Separate production and attraction models are developed using generation rates (Pickett, 2001; Wilbur Smith associates, 2008; Dallas-Fort worth Regional Travel Model Description, 2006; and Kikuchi et al., 2004) specific to each generator. These rates are dependent on the location, activity level of the generator and are either borrowed from other areas or developed from the survey data (traffic counts and characteristics of special generators, etc.) on number of trips attracted. These separate models are mostly developed using linear regression analysis.
2) Special generators are assigned unique trip rates obtained from the ITE Trip Generation Manual (Lima & Associates, 2006; Pearson et al., 2009) or other trip generation manuals like San Diego Municipal Code, 2003 to capture trip

attraction. Trip attractions due to special generators are estimated using this trip rate per trip generation variable[19].

Also, A review of various transit analysis studies show the following way of treating special generators:

1) Separate models are developed using trip rates obtained from the survey data [On-board surveys (Parsons Brinckerhoff, 2000) and site surveys or interviews (Kurth, 1997; The Duffey Company, 2000; Usvyat, 2009)].

Table 20 presents special generator categories with their specific ITE Trip Generation Manual recommended trip rates, relevant studies by different investigators and the corresponding variables evaluated with results. The special generators mentioned in table 20 were selected as they are more likely to attract transit trips. The first part of table 20 with the heading "Trip Rate from ITE Trip Generation Manual" gives the trip rate for each special generator category using the ITE trip generation manual, 8th Edition. The trip rates were obtained by matching each special generator category with the closest available ITE land use category. The trip rates are available for various independent variables on a weekday, Saturday and Sunday. The other part of table 20 with the heading "Variables Used to Explain Special Generator Trip Generation in the Literature" gives the description of each study on how it deals with a specific special generator and includes the list of variables used in that study to explain special generator trip attraction. Summary of each study and dataset is given in the Appendix A.

[19] Trip generation variable can be defined as Independent variable which best explains the trip attraction of that special generator

Table 20 Tabulation of Special Generators With ITE Trip Rates, Relevant Studies and Corresponding Variables Used

<table>
<tr><th rowspan="2">Sr. No</th><th rowspan="2">Special Generators</th><th colspan="4">Trip Rate from ITE Trip Generation Manual</th><th colspan="2">Variables Used to Explain Special Generator Trip Generation in the Literature</th></tr>
<tr><th>Unit [Independent Variable(X)]</th><th>On a</th><th>Average Trip rate / unit</th><th>Fitted Curve Equation</th><th>List of Variables Used</th><th>Study Description</th></tr>
<tr><td rowspan="9">1</td><td rowspan="9">Commercial Airports</td><td rowspan="3">Employees</td><td>Weekday</td><td>13.4</td><td>--</td><td rowspan="3">Number of Boardings (Enplanements).</td><td rowspan="3">Hojong et al. (2008) developed a trip generation model to estimate number of person trip attracted by using number of enplanements as an independent variable in the regression analysis. Trip attraction is obtained for 66 international airports in U.S by using data from Bureau of Transportation Statistics T100 international segment database.</td></tr>
<tr><td>Saturday</td><td>12.2</td><td>--</td></tr>
<tr><td>Sunday</td><td>14.7</td><td>--</td></tr>
<tr><td rowspan="3">Average Flights per Day</td><td>Weekday</td><td>104.73</td><td>--</td><td rowspan="2">Number of Deplaning Passengers. Number of Boardings</td><td rowspan="2">In the Laredo Travel Demand Model prepared by Wilbur Smith Associates (2008), trip attraction for international airport is estimated based on the number of deplaning passengers and number of boardings. Trip attraction model was developed using linear regression analysis.</td></tr>
<tr><td>Saturday</td><td>98.46</td><td>--</td></tr>
<tr><td>Sunday</td><td>119.61</td><td>--</td><td rowspan="2">No. of Employees</td><td rowspan="2">In the Lincoln MPO Travel Demand Model, ITE Trip Generation Manual, 7th Edition is used to calculate the trip attraction. Trip attraction for airports is obtained based on the number of employees in the airport.</td></tr>
<tr><td rowspan="3">Commercial Flights per Day</td><td>Weekday</td><td>122.21</td><td>--</td></tr>
<tr><td>Saturday</td><td>113.04</td><td>--</td><td rowspan="2">Number of Boardings</td><td rowspan="2">2007 Passenger Boarding and All-Cargo Data maintained by Federal Aviation Administration (FAA) can be used for the trip generation model. This dataset contains total number of boardings for the Commercial Service Airports (at least 2500 passenger boardings/year). This data only gives annual boarding at commercial service airports.</td></tr>
<tr><td>Sunday</td><td>137.71</td><td>--</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Water port / Marine Terminal</td><td>Number of Berths</td><td>Weekday</td><td>171.52</td><td>298.56(X) - 417.4</td><td rowspan="2">Acreage of the port.</td><td rowspan="2">City of San Diego has developed its own Trip Generation Manual. Trip rates for each land use were obtained by conducting detailed local surveys (vehicle trips) at various sites of each land use type. Vehicle trip rate for Marinas is 20 trips /acre.</td></tr>
<tr><td>Acres</td><td>Weekday</td><td>11.93</td><td>18.01(X) - 287.06</td></tr>
<tr><td rowspan="6">3</td><td rowspan="6">Major regional amusement parks</td><td rowspan="3">Employees</td><td>Weekday</td><td>8.33</td><td>--</td><td rowspan="3">Acreage of the Park. No. of Visitors / day.</td><td rowspan="3">In the Laredo Travel Demand Model prepared by Wilbur Smith Associates (2008), trip attraction for regional parks is estimated based on the number of visitors/day and acreage of the park. Linear regression analysis was performed using data from the traffic counts.</td></tr>
<tr><td>Saturday</td><td>22.08</td><td>--</td></tr>
<tr><td>Sunday</td><td>20.96</td><td>--</td></tr>
<tr><td rowspan="3">Acres</td><td>Weekday</td><td>75.76</td><td>--</td><td rowspan="3">Total attendance per day.</td><td rowspan="3">Kurth et al. (1997) developed a four step model to estimate the annual transit trips attracted by amusement parks. Trip generation, trip distribution, mode choice and transit assignment models were used based on the data (attendance per day) obtained from the local surveys.</td></tr>
<tr><td>Saturday</td><td>180.2</td><td>--</td></tr>
<tr><td>Sunday</td><td>171.02</td><td>--</td></tr>
</table>

Table 20 Continued

Sr. No	Special Generators	Trip Rate from ITE Trip Generation Manual: Unit [Independent Variable(X)]	On a	Average Trip rate / unit	Fitted Curve Equation	Variables Used to Explain Special Generator Trip Generation in the Literature: List of Variables Used	Study Description
4	Major sports facilities - Stadia, Arena etc	Employees	**Weekday**	10	--	Capacity of the Facility.	In the Laredo Travel Demand Model prepared by Wilbur Smith Associates (2008), trip attraction for regional sports facilities is estimated based on the capacity of the facility. Trip attraction model was developed using linear regression analysis.
		Acres	Weekday	33.33	--	Total Attendance per event	Kurth et al. (1997) developed a four step model to estimate the annual transit trips attracted by stadiums. Trip generation, trip distribution, mode choice and transit assignment models were used based on the data (attendance per event) obtained from the local surveys.
5	Recreational community center	Members	Saturday	0.07	--	Area of the facility (1000 Sq.ft).	City of San Diego has developed its own Trip Generation Manual. Trip rates for each land use were obtained by conducting detailed local surveys (vehicle trips) at various sites of each land use type. Vehicle trip rate for Recreational Building is 45 trips/1,000 sq. ft.
			Sunday	0.15	--		
		Employees	Weekday	27.25	--		
			Saturday	18.34	--		
			Sunday	12.03	--		
		1000 Sq.ft Gross Floor Area	Weekday	22.88	--		
			Saturday	9.1	--		
			Sunday	13.6	--		
6	High school	Students	Weekday	1.71	0.81 Ln(X) + 1.86	Number of students. Number of staff.	In the Laredo Travel Demand Model prepared by Wilbur Smith Associates (2008), trip attraction for high school is estimated based on the number of students and number of staff. Linear regression analysis was performed using data from the survey of high schools.
			Saturday	0.61	--		
		1000 Sq.ft Gross Floor Area	Weekday	12.89	--		
			Saturday	4.37	--		
		Employees	Weekday	19.74	1.13 Ln(X) + 2.31	Number of students enrolled.	School Enrollment data is collected annually in the October Current Population Survey (CPS) and can be used for the trip attraction model. http://www.census.gov/population/www/socdemo/school.html
			Saturday	6.57	--		
7	College / University	Students[§]	Weekday	2.38	2.23(X) + 440	Number of students. Number of staff.	In the Laredo Travel Demand Model prepared by Wilbur Smith Associates (2008), trip attraction for college/university is estimated based on the number of students and number of staff. Linear regression analysis was performed using data from the survey of colleges/universities.
			Saturday	1.3	--	Number of Employees.	In the Dallas-Fort Worth Regional Travel Model, trips attracted by college/university is computed by applying the trip attraction rates to the employment and adding extra increment trips associated with college/university . The number of incremental trips for college/university is obtained by taking the difference of cross classification model generated trip rates and trip rates obtained from regional travel survey.
		Employees	Weekday	9.13	0.74(X) + 3.92		
			Saturday	3.12	--	Number of Employees.	In the Lincoln MPO Travel Demand Model, ITE Trip Generation Manual, 7^{th} Edition is used to calculate the trip attraction. Trip attraction for university main campus is obtained based on the number of employees.

Table 20 Continued

Sr. No	Special Generators	Trip Rate from ITE Trip Generation Manual				Variables Used to Explain Special Generator Trip Generation in the Literature	
		Unit [Independent Variable(X)]	**On a**	**Average Trip rate / unit**	**Fitted Curve Equation**	**List of Variables Used**	**Study Description**
8	Hospital	Beds	Weekday	11.81	7.42(X) + 1733.31	Number of Employees. Number of Beds.	In the Laredo Travel Demand Model prepared by Wilbur Smith Associates (2008), trip attraction for hospital/medical center is estimated based on the number of employees and number of beds. Linear regression analysis was performed using data from the survey of hospitals/medical centers.
			Saturday	8.14	0.58 Ln(X) + 4.65		
			Sunday	7.19	0.61 Ln(X) + 4.38		
		Employees	Weekday	5.2	4.4(X) + 711.46	Number of Employees.	In the Lincoln MPO Travel Demand Model, ITE Trip Generation Manual, 7th Edition is used to calculate the trip attraction. Trip attraction for medical centers is obtained based on the number of employees.
			Saturday	3.78	2.95(X) + 691.43		
			Sunday	3.34	2.56(X) + 663.23		
		1000 Sq.ft Gross Floor Area+	Weekday	16.5	10.13(X) + 2191.79	Number of Beds	American Hospital Association (AHA) collects data on number of beds for more than 6500 AHA registered hospitals throughout the United States. This dataset is available at state and regional geographic level and can be used.
			Saturday	10.18	0.43 Ln(X) + 5.79	Number of Employees.	In the Dallas-Fort Worth Regional Travel Model, trips attracted by hospital is computed by applying the trip attraction rates to the employment and adding extra increment trips associated with hospital. The number of incremental trips for hospital is obtained by taking the difference of cross classification model generated trip rates and trip rates obtained from regional travel survey.
			Sunday	8.91	3.53(X) + 1937.21		
9	Shopping Center (SC)	1000 Sq.ft Gross Leasable Area	Weekday	42.94	0.65 Ln(X) + 5.83	Number of Parking Spaces. Number of Stores. Type of Stores. Floor area of SC.	Kikuchi et al. (2004) developed macroscopic and microscopic model to estimate the attraction rate of SC. In macroscopic approach, relationship between the listed variables & attraction rate was obtained using regression analysis and in the microscopic approach, attraction rate of SC was taken as weighted sum of attraction rates of individual stores. The data used in both the approaches was obtained by the surveys conducted at various shopping centers.
			Saturday	49.97	0.63 Ln(X) + 6.23	Number of Employees.	In the Lincoln MPO Travel Demand Model, ITE Trip Generation Manual, 7th Edition is used to calculate the trip attraction. Trip attraction for malls is obtained based on the number of employees.
			Sunday	25.24	15.63(X) + 4214.46	Number of Employees.	In the Laredo Travel Demand Model prepared by Wilbur Smith Associates (2008), trip attraction for shopping center is estimated based on the number of employees. Linear regression analysis was performed using data from the traffic counts done at various shopping centers.

Table 20 Continued

Sr. No	Special Generators	Trip Rate from ITE Trip Generation Manual				Variables Used to Explain Special Generator Trip Generation in the Literature	
		Unit [Independent Variable(X)]	On a	Average Trip rate / unit	Fitted Curve Equation	List of Variables Used	Study Description
10	Free-Standing Superstore	1000 Sq.ft Gross Floor Area	Weekday	53.13	1.35 Ln(X) + 2.11	1000 Sq.ft Gross Floor Area.	The Texas Transportation Institute (TTI) conducted a nationwide discount superstore trip generation study by collecting site and trip generation data for typical season, peak hours using manual or video counting. Trip rate (per 1000 Sq.ft GFA) is calculated for various time periods by plotting the best fitted curve for the data collected.
			Saturday	64.07	1.45 Ln(X) + 1.74		
			Sunday	56.12	1.74 Ln(X) + 0.09	Area of the Facility (1000 Sq.ft).	City of San Diego has developed its own Trip Generation Manual. Trip rates for each land use were obtained by conducting detailed local surveys (vehicle trips) at various sites of each land use type. Vehicle trip rate for superstore is 40 trips /1000 Sq.ft.
11	Park-and-Ride Lot with Bus service	Parking Spaces	Weekday	4.5	4.04(X) + 117.33	Service area population. Ratio of auto costs to transit costs. Distance from park-and-ride facility to major employment centers. Number of express buses during the morning (AM) peak. Best (not average) time between the park-and-ride facility and the CBD. Presence of nearby park-and-ride facilities. Availability of midday service.	Robert Pillar (1997) developed the planning and design manual for park-and-ride facilities. The methodology used for estimating the park-and-ride demand is all about defining a service area (catchment area) for the park and ride facilities and then developing equations based on the lot attributes using multivariate regression analysis. The listed variables are used in the model based on availability of data from past surveys and existing database and the potential ease of developing similar data for the evaluation of future lots.
		Occupied Spaces	Weekday	9.62	--		
		Acres	Weekday	372.32	--		Park-and-ride is also modeled using the traditional modeling technique, which is identifying the attraction and production zones and then determining the proportion of trip interchange for park and carpool and bus park and ride users.
12	Intermodal Terminals					Number of Employees. Building /Floor area.	Trip rate was calculated using linear regression based on the variables number of employees and floor area. Data for the analysis is obtained by conducting surveys. http://praytorianguard.com/blog1/?p=456

A project on "Understanding Transit: Basic Course Material on Public Transportation" executed by the Center for Urban Transportation Studies, University of Wisconsin-Milwaukee suggest site interviews at special generators as an important source for transit analysis. Such interviews will be helpful in knowing the location, features (size in terms of visitors, employment, area, etc.) and ridership developed by special generators. Also, a paper by Carter (1984) focuses on the importance of special generator information in transit and traffic analysis. The author presents detailed recommendations on questionnaire content and procedures. According to the special generators report by LSA Associates, Inc. (2008), review and application of special generator developments is one of the important aspects in developing the travel demand model. Firstly, potential special generators are identified and categorized into broad categories like event centers, airports, stadiums, resorts, theme parks, religious, tourist destinations etc. based on the type of development, establishment, or area. Secondly, special generators are evaluated based on the database, which includes the following information on special generators:

1) Description and location of activity
2) Duration and recurrence of activity (single event, throughout the day, random vs. scheduled, etc.)
3) Category of the special generator
4) Trip distribution (local vs. regional, etc.) and mode choice information
5) The seasonal variability of trip-making
6) Independent trip generation (activity) variables and their availability

The most important data to develop separate models for each special generator are the independent trip generation (activity) variables as they define the trip attraction capability of a particular special generator.

Different data sources were explored to obtain information on trip generation (explanatory) variable available for various generators. The datasets useful for defining the attraction capability of the following special generators are:

1) For special generators like schools, colleges and universities, the number of enrollments best describes the trip generation. This data can be obtained from the following datasets: 2000 U.S Census data, Current Population Survey (CPS) and American Community Survey (ACS).
2) For airports, annual passenger enplanement for commercial service airports can be obtained from the Federal Aviation Administration (FAA) - Passenger Boarding (Enplanement) and All-Cargo Data. This dataset is easily available for the current year and the next fiscal year.
3) For hospitals, the American Hospital Association (AHA) – annual survey database can be used. This dataset provides the number of beds for more than 6500 AHA registered hospitals throughout the United States. This dataset is available at the state and the regional geographic level. This dataset is not available online and can be ordered in the form of a CD and a book.

Based on the literature review and the availability of information on the trip generation variable for each special generator category, best, next best and other explanatory variables were stated for each special generator. Table 21 shows the options for explanatory variables of each special generator.

Table 21 List of Various Special Generators and the Options (Best, Next Best and Other) for the Explanatory Variables of Each Generator

Special generators	Options for Explanatory Variables		
	Best	Next Best	Other
Regional Airports	Boardings (Enplanements)	Plane Arrivals/departures	Employees
Water port/Marine Terminals	Area (Acres)		Employees
Major Regional Amusement Parks	Visitors/day	Parking spaces	Employees or acres
Major Sports Facilities	Total Attendance/event	Capacity (seats)	Parking spaces
Recreational Community Center	Visitors/day	Parking spaces	Area (1000 Sq.ft)
High School	Students Enrolled	Employees	-
College/University	Students Enrolled	Employees	-
Hospitals	Number of Beds	Employees	-
Shopping Centers (SCs)	Employees	Parking Spaces	Floor Area of SC
Free Standing Superstore	Area (1000 Sq.ft Gross Floor Area)	-	-
Park-and-Ride Lots with Transit Service	Number of Parking Spaces Service Area Population Ratio of Auto Costs to Transit Costs. Distance from Park-and-Ride Facility to Major Employment Centers Number of Express Buses during the Morning (AM) Peak Best (not average) Time Between the Park-and-Ride Facility and the CBD Presence of Nearby Park-and-Ride Facilities Availability of Midday Service		
Intermodal Terminals	Employees	Building /Floor Area	-

To enhance the trip attraction capability of the TBEST model, special generators can be represented by the explanatory variables which best describe the activity levels at that generator.

5.4 Analysis

Exploratory analysis has been performed to achieve the above mentioned possibilities of enhancing trip attraction of the TBEST model. It aims at capturing trips generated by employment, trips generated using parcel land use based trip rates, total weekday boarding, presence of special generators and, area of the special generators and non-residential land uses within the stop buffers for all the stops of the four routes shown in table 3. The analysis will give insights on the various strategies discussed above in this chapter and also help in defining suggestions for the improvement of the TBEST model.

Table 22 Potential Special Generators in the Parcel Data

DOR Land Use Code	PROPERTY TYPE
013	Department Stores
014	Supermarkets
015	Regional Shopping Centers
016	Community Shopping Centers
020	Airports (private or commercial)[20], bus terminals, marine terminals, piers, marinas.
028	Parking lots (commercial or patron) mobile home parks
072	Private schools and colleges
073	Privately owned hospitals
082	Forest, parks, recreational areas
083	Public county schools
084	Colleges
085	Hospitals

Based on the special generators identified in the previous chapter, parcel land uses shown in table 22 were believed to generate or attract trips at a higher rate as compared to other land uses[21]. The above mentioned land uses were selected from Duval county's parcel data and a separate point layer file was created. Trips generated by each land use were calculated by multiplying the trip rates obtained using the ITE trip generation

[20] There is an ambiguity in the Duval County's parcel data regarding how airports are defined as the Jacksonville airport is coded in counties (86) land use and not in land use code – 20.

[21] To accurately define potential special generators, there is need to go through each land use either using area or some other variable like trip rates

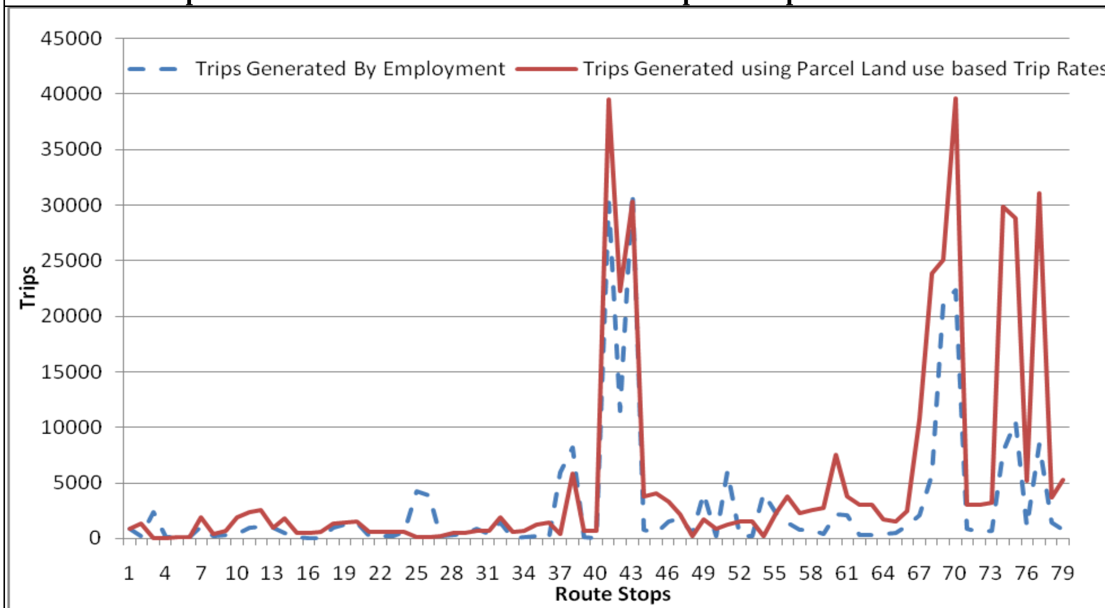
manual (discussed in section 5.2) by the total useable area given in the parcel data. Quarter mile buffers for each stop were generated and spatially joined to the special generator layer file and non-residential parcels to determine the number of special generators in each stop buffer and total trips generated within each stop buffer respectively. Also, stop buffers were spatially joined to the InfoUSA employment data layer file to determine the employment by type within each stop buffer. The trips generated by employment were calculated using the trip attraction per employee shown in table 15. The stop buffers having zero special generators were studied separately as compared to stops with one or more special generators in the catchment area.

5.5 Results

This section describes the results of this analysis based on the trips generated by employment, trips generated using parcel land use based trip rates, total weekday boarding, presence of special generators in the stop buffer, and the useable area of the special generators and non-residential parcels within the stop buffer. Figure 12 shows graphs capturing the difference between trips generated by employment and trips generated using parcel land use based trip rates for both stop buffers with and without special generators. The graphs show that stops with special generators have large differences in the trips generated when compared to stops without special generators in their catchment area. The absolute percent difference between the trips obtained using employment and parcel land use based trip rates was computed for each stop. It was observed that the absolute percent difference is higher for stops with special generators when compared to stops without them.

The KS (Kolmogorove-Smirnov) test was performed to test if the trips generated using employment and parcel land use based trip rates are statistically different. The KS-test showed a lower p-value of 0.003 for stops with special generators resulting in the rejection of the null hypothesis of no statistical difference between the trips; whereas, a p-value of 0.199 for stops without special generators resulted in the rejection of the alternative hypothesis of statistical difference between the trips. This shows that trips generated by employment and trips generated using parcel land use based trip rates are similar for stops without special generators. Detailed results for each stop of all four routes are presented in Appendix B.

Trips Generated within 1/4th mile Buffer of Stops with Special Generator



Trips Generated within 1/4th mile Buffer of Stops without Special Generator

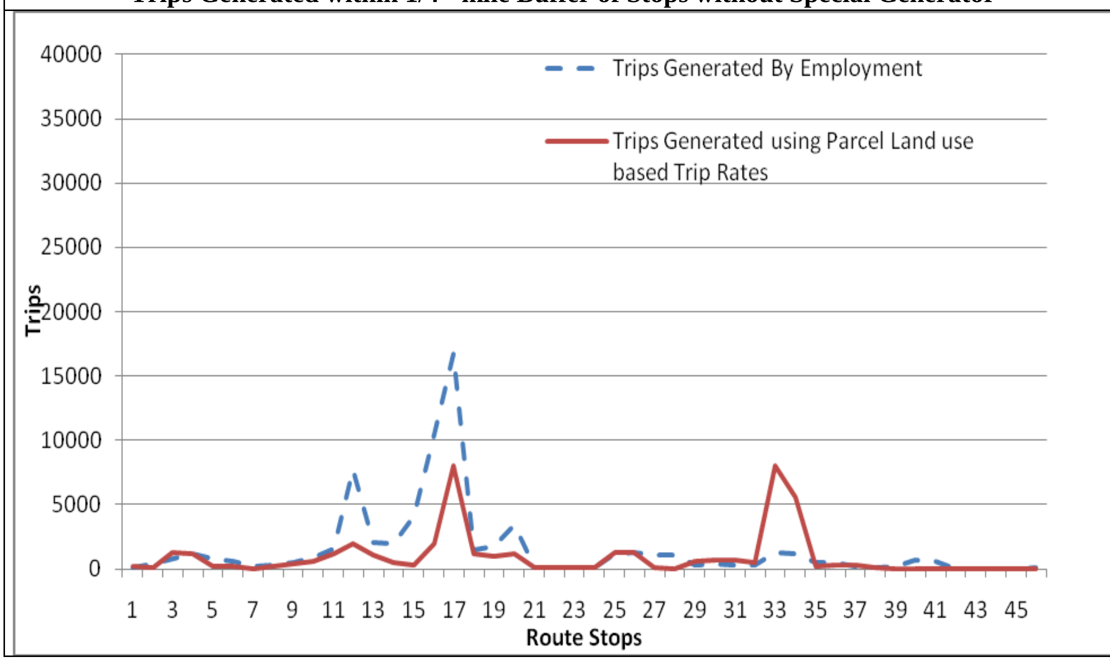


Figure 12 Graphs Showing Differences Between Trip Generated by Employment and Trip Generated Using Parcel Land Use Based Trip Rates for Route P7 Stops With and Without Special Generator

A linear regression analysis was performed with total weekday boarding as the dependent variable and total employment (currently used in the TBEST model), trips generated by both employment and parcel land use based trip rates as the independent variables for both approaches (stops with special generators and stops without special generators). The result of this analysis given in table 23 shows that for stops with special generators, the coefficient and t-stats of trips generated using parcel land use based trip rates (model 3) are higher than that of total employment (model 1) and trip generated by employment (model 2). Also, the coefficient and t-stats of model 4 where both the trips generated by employment and trips generated using trip rates were used in the same model show similar results. This indicates that trips generated using trip rates better explain total boarding at stops with special generators as compared to the trips generated by employment. On the other hand, results of the stops without special generators show that total employment, trips generated by employment and parcel land use based trip rates are not statistically significant in explaining the total boarding. This clearly conveys that none of these independent variables are able to explain total boarding for stops without special generators, but for stops with special generators, trips generated using parcel land use based trip rates should be used[22].

[22] The R^2 values in this analysis are very low and therefore it is difficult to make strong conclusions or implications from this analysis

Table 23 Results of the Linear Regression Analysis Between Total Boarding, Total Employment, Trips Generated by Employment and Trips Generated Using Trip Rates for Stops With and Without Special Generator

Independent Variable	**Parameter Estimates (t-stats)**							
	Stops with Special Generator				**Stops without Special Generator**			
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Constant	4.175 (3.18)	4.156 (3.18)	3.415 (2.56)	3.449 (2.58)	3.674 (4.44)	3.742 (4.54)	3.963 (4.78)	3.841 (4.58)
Total Employment	0.163 (2.27)	-	-	-	0.064 (0.84)	-	-	-
Trips generated by Employment	-	0.167 (2.33)	-	-0.058 (-0.46)	-	0.050 (0.66)	-	0.107 (0.95)
Trips generated using Parcel Land use based Trip rates	-	-	0.225 (3.20)	0.274 (2.19)	-	-	0.003 (0.04)	-0.077 (-0.68)
R^2	0.027	0.028	0.051	0.052	0.004	0.003	0.000	0.005
N	192				177			

The KS test was performed again between trips generated by employment and trips generated using trip rates based on the size (area in sq.ft.) of the special generators within the stop buffer. This helps in defining the threshold value for the size of the special generator within the stop buffer. The stops with special generators above this threshold value will results in statistical differences between the trips generated by employment and trips generated using parcel land use based trip rates, while the special generators below this threshold value will not present any statistical differences. The results of this test show a threshold value of 7000 sq.ft. for the size of the special generator.

To test variation of size (area in square foot) of the non-residential land uses within the stop buffer and total boarding between stops with and without special generators, Levene's test for equality of variances and t-test for equality of means were performed. Levene's test is used to evaluate the equality of variances in different samples.

If the resulting p-value of Levene's test is less than some critical value (0.05 in this case), the obtained differences in sample variances are unlikely to have occurred based on random sampling. Table 24 shows the results of the Levene's test and t-test for total boarding and area of the land uses in the stop buffer between stops with and without special generators. The results of the Levene’s test show a high p-value (0.384), which results in the rejection of the alternative hypothesis of unequal variances of total boarding for stops with and without special generators. The area of the land uses within each stop buffer shows very low p-value (0.00). Thus, the null hypothesis of equal variances is rejected and it is concluded that there is a difference between the variances in the area. The t-test assesses whether the means of two groups are statistically different from each other. The results of the t-test show that the means of the total boarding are equal for stops with and without special generators i.e. high p-value (0.259). Whereas, the means of the area of land uses in the stop buffer are statistically different for both stops with and without special generators .i.e. low p-value (0.000)

Table 24 Results of the Levene's Test and T-Test for Total Boarding and Area of the Land Uses in the Stop Buffer Between Stops With and Without Special Generator

	Total Boarding		**Area of the Land Uses in the stop buffer**	
	Stops without Special Generator	Stops with Special Generator	Stops without Special Generator	Stops with Special Generator
N	177	192	177	192
Mean	3.975	5.575	37329.29	235956.75
Std. Deviation	9.916	16.249	59332.366	4.030
Levene's Test for Equality of Variances (p-value)	0.384		0.000	
t-test for Equality of Means (p-value)	0.259		0.000	

Also, linear regression analysis was performed with total boarding at each stop as the dependent variable and total employment, special generator dummy and special generator area (interaction variable between special generator dummy and area of the special generator) as independent variables. Since at present employment and special generator dummy variable are the only variables used in the TBEST model to measure transit trip attractiveness, this analysis was performed to test if the interaction variable is more effective in capturing the impact of special generators on trip attraction as compared to employment and special generator dummy variable. The results in table 25 show a higher R^2 value for the employment and special generator area variable as compared to the employment and special generator dummy variable[23]. This indicates that the interaction variable explains total boarding more accurately as compared to the special generator dummy variable.

Table 25 Results of the Linear Regression Analysis Between Total Boarding, Special Generator Dummy Variable and Special Generator Area

Independent Variable	Parameter Estimates (t-stats)	
Constant	3.508 (3.42)	3.158 (3.87)
Total Employment	0.146 (2.70)	0.121 (2.30)
Special generator dummy (1 if special generator is present within stop buffer, 0 otherwise)	0.027 (0.51)	-
Special generator area in sq.ft	-	0.131 (2.49)
R^2	0.023	0.040
N	369	

[23] The R^2 values in this analysis are very low and therefore it is difficult to make strong conclusions or implications from this analysis.

CHAPTER 6 CONCLUSIONS

6.1 Conclusions

This study uses exploratory analysis to obtain insights on the strategies used to enhance the precision of input data and the trip attraction capabilities of the TBEST model. The results of the analysis to identify the differences in activity levels (population and employment) within transit stop buffers due to the change from aggregate census data to disaggregate parcel data showed statistical differences in disaggregate and aggregate level population and employment. The results of the linear regression analysis indicate that disaggregate level population and employment explain total boarding at each stop more accurately when compared to the aggregate level population and employment. Based on these results, it can be said that the use of parcel level data can potentially improve the accuracy in capturing the activity levels within the catchment area of each stop. Other findings that surfaced from this analysis are: 1) the differences between the aggregate and disaggregate population and employment decreases with an increase in the size of the catchment area of each stop.2) change in input data from disaggregate level to aggregate level affects total employment more when compared to population.3) aggregate level analysis leads to the underestimation of total employment due to the assumption of uniform spatial distribution of employment within each block group.

For the enhancement of trip attraction, possibilities such as employment trip attraction, parcel land use based trip attraction and special generator enhancement were explored. The results of this analysis show that the absolute percent difference between trips obtained by employment and trips obtained using parcel land use based trip rates is higher for stops with special generators when compared to stops without them. Also, the trips obtained by employment and trips obtained using trip rates are statistically different for stops with special generators. Further, the results of the linear regression analysis show that trips generated using parcel land use based trip rates explain total boarding at stops with special generators better than total employment and trips generated by employment. The threshold value of 7000 sq.ft for size of the special generator was identified. The above mentioned findings suggest the use of parcel land use based trip rates to capture trip attraction, specifically for stops with special generators of area greater than 7000 sq.ft.

An extensive literature review shows that special generators are usually handled separately using the information on location, category, and independent trip generation variable which best describes the attraction at that special generator. Based on the availability of data on the trip generation variable and literature review, the variables which best describe the activity levels at each special generator were identified (shown in table 21). The information on the explanatory variables can be obtained either using datasets mentioned in section 5.3.1 or by conducting site interviews or surveys at that special generator. Also, defining special generators in terms of trip attraction rather than using a dummy variable in the model will help in improving the predictive capability of the TBEST model. Therefore, linear regression analysis was performed to explore the interaction variable between the special generator dummy and area of the special generator compared to the employment and special generator dummy variable. The results of the analysis showed that the interaction variable can better explain special generator attraction when compared to the employment and special generator dummy variable.

6.2 Suggestions for Enhancement of TBEST Model

Based on the findings from the analysis and literature review, the following suggestions can be made for the enhancement of the TBEST model:

1) Strategies for disaggregating the block group level demographics to parcels stated in table 4 should be used. The use of parcel data with disaggregated demographics relaxes the assumption of uniform spatial distribution of demographic data over block group level of geography resulting in the enhancement of predictive capability of the TBEST model.
2) To better capture trip attraction in the TBEST model, parcel land use based trip attraction should be considered only for stops with special generators of area greater than 7000 sq.ft.as the results show that trips captured by employment and trip rates are similar for stops without special generators and stops with special generators of area less than 7000 sq.ft.
3) Each special generator can be modeled separately using the explanatory variables which best describe the activity levels (shown in table 21) at that generator. The information on the explanatory variables can be obtained by using datasets mentioned in section 5.3.1 specific to each type of generator. Also, site interviews or surveys can be conducted at that special generator and data on 1) location of the special generator, 2) duration of the special generator, 3) trip generation variables (attendance, employees, area, etc.) and 4) trip distribution and modal share should be obtained to account for attraction in the TBEST model.

4) Another way of treating special generators would be to use an interaction variable between special generator dummy and size (square footage, etc.) of the special generator, instead of simply using special generator dummy variable in the TBEST model. Using the interaction variable will definitely be more effective in capturing the impact of special generators on trip attraction.

REFERENCES

Baik, H., A. A. Trani, N. Hinze, H. Swingle, S. Ashiabor, and A. Seshadri. Forecasting Model for Air Taxi, Commercial Airline, and Automobile Demand in the United States. Transportation Research Record: Journal of the Transportation Research Board, No. 2052, Washington, D.C., 2008, pp. 9–20.

Carter, M. Transit and Traffic Analysis, Transportation Research Board Special Report 206, 1985, pp. 152-157.

Hull, Edwin, Edwin Hull Associates, Application of a Park-and-Ride Forecasting Procedure in the Greater Vancouver Transportation Model, presented in the 13th Annual International EMME/2 Users' Group Conference, Houston, Texas, October,1998.

Kikuchi, S., M. Felsen, S. Mangalpally and A. Gupta. Trip Attraction Rates of Shopping Centers in Northern New Castle County, Delaware, prepared for the Delaware Department of Transportation, July, 2004.

Kittelson & Associates, Inc., TCRP Report 88: A Guidebook for Developing a Transit Performance-Measurement System, Transportation Research Board, Washington, D.C., 2003.

Kurth, David L., B. V. Meter, S. Myung and M. C. Shaefer. Quantifying Special Generator Ridership in Transit Analysis. Proceedings of the Sixth TRB Conference on the Application of Transportation Planning Methods, Dearborn, Michigan, May 1997.

Lima & Associates, Lincoln MPO Travel Demand Model Documentation, prepared for the Lincoln Metropolitan Planning Organization, January, 2006.

LSA Associates, Inc., Weekend Travel Demand Model: Technical Memorandum #9 - Special Generators for the Weekend Model prepared for the Southern California Association of Governments, June, 2008. http://www.lsa-assoc.com/SCAG/

McDonnell, S., S. Ferreira, and F. Convery: Impact of Bus Priority Attributes on Catchment Area Residents in Dublin, Ireland, Journal of Public Transportation, 9(3), 2006, 137–62.

Murray, A., R. Davis, R. Stimson and L. Ferreira. Public transport access. Transportation Research D 3, 1998, 319-28.

Murray, A. Strategic Analysis of Public Transport Coverage. Socioeconomic Planning Sciences 35, 2001, pp. 175-188.

Neilson, G. K., and W. K. Fowler. Relation between Transit Ridership and Walking Distances in a Low Density Florida Retirement Area. Highway Research Record No. 403, 1972, pp. 26–34.

Parsons Brinckerhoff, WACOG Connector Program Transit Feasibility and Implementation Plan, Task 1 # Transit Demand Model Summary, prepared for the Western Arizona Councils of Governments (WACOG), September, 2000.

Pascoe, R. Updating Demographics Using Parcel Data for Transit Corridor Analyses. Presented at National Center for Transit Research (NCTR's) GIS in Transit Conference, Tampa, Florida, 2007.

Passenger Boarding Statistics. FAA, U.S. Department of Transportation. http://www.faa.gov/airports_airtraffic/airports/planning_capacity/passenger_allcargo_stats/. Updated September 26, 2008.

Pearson, David F., B. S. Bochner, P. Ellis, M. I.Ojah. Discount Superstore Trip Generation. Institute of Transportation Engineers (ITE) Journal, June 2009.

Pickett, W. Kirby. Traffic Data and Analysis Manual: Chapter 2 (Section 2) - Texas Travel Demand Model Package. http://onlinemanuals.txdot.gov/txdotmanuals/tda/urban_travel_demand_forecasting.htm. Updated September 01, 2001.

Pillar, Robert S., Parsons Brinckeroff Quade & Douglas, Inc., A Comprehensive Planning and Design Manual for Park-and-Ride Facilities: Chapter 5 - Suburban Park-and-Ride Demand Estimation Techniques, October,1997.

Reese, M. A GIS Analysis of the Bus Rapid Transit System in Curitiba, Brazil. Student project for course PLAN 512 GIS for Planners, University of Virginia, Fall 2007. http://www.arch.virginia.edu/~dlp/Courses/P512F07/CuritibaGIS_presentationopt.pdf_

School Enrollment Data. Current Population Survey (CPS), U.S Census Bureau. http://www.census.gov/population/www/socdemo/school.html. Updated October, 2007.

Sullivan, S. O and J. Morrall, Walking distances to and from light-rail transit stations, Transportation Research Record No. 1538, 1996, pp. 19–26

T-100 International Segment (All Carriers) Database. Bureau of Transportation Statistics, U.S. Department of Commerce. www.transtats.bts.gov/Fields.asp?Table_ID=261. Updated December, 2008.

T-BEST (Transit Boardings Estimation and Simulation Tool), Florida Department of Transportation, Tallahassee. 2009. www.tbest.org

Trip Generation Manual. San Diego Municipal Code, May, 2003. http://www.sandiego.gov/planning/pdf/tripmanual.pdf.

The Duffey Company and Nelson/Nygaard Consulting Associates, Transit Impact Fee Analysis: Technical Memorandum #2 Land Use and Trip Generation rates, prepared for the San Francisco Planning Department, September, 2000.

Transit Route Location and Analysis, Understanding Transit: Basic course material on Public Transportation prepared by Center for Urban Transportation Studies, University of Wisconsin-Milwaukee, July 2006. http://www4.uwm.edu/cuts/utp/

Transportation Department of North Central Texas Council of Governments (NCTCOG), Dallas-Fort Worth Regional Travel Model Description, June, 2006.

Trip Generation Manual. San Diego Municipal Code. http://www.sandiego.gov/planning/pdf/tripmanual.pdf. May, 2003.

Usvyat, Len, L. Meckel and M. Dicarlantonio. Sketch Model to Forecast Heavy Rail Ridership. Proceedings of 12th TRB National Transportation Planning Applications Conference, Houston, Texas, May 2009.

Wilbur Smith Associates, Laredo Metropolitan Transportation Plan 2005- 2030: Chapter 3 – Demographics and Travel Demand Model, prepared for the Laredo Metropolitan Planning Organization, January, 2008.

Xuehao, C., S. Polzin, R. Penyala, N. Siddiqui and I. Ubaka. A Framework of Modeling and Forecasting Stop-Level Transit Patronage. Presented at 86th Transportation Research Board Annual Meeting, Washington, D.C., 2007.

Zhao, F., L.-F. Chow, M.-T. Li, I. Ubaka, and A. Gan. Forecasting Transit Walk Accessibility: Regression Model Alternative to the Buffer Method. Transportation Research Record No. 1835, TRB, National Research Council, Washington, D.C., 2003, pp. 34–41.

APPENDICES

Appendix A: Summary of Studies and Datasets Reviewed for Special Generator Enhancement

A.1 Special Generator: School

For special generators like schools, colleges and universities, number of enrollments best describes the trip generation. This data can be obtained from the following datasets: 2000 U.S Census data, Current Population Survey (CPS) and American Community Survey (ACS).

1) 2000 U.S Census Data:

Data on school enrollment was obtained from answers to long-form questionnaire filled by the sample of the population. People were classified as enrolled in school if they reported attending a "regular" public or private school or college at any time between February 1, 2000, and the time of enumeration. The Census 2000 Summary File 3 data are available from the American Fact finder on the internet (*factfinder.census.gov*).This data file gives annual enrollments and is available by sex, age, type of school and type of college. The Census 2000 Summary File 3 (SF 3) - sample data contains the following tables:

P36 Sex by school enrollment by level of school by type of school for the population 3 years and over.

P38 Armed forces status by school enrollment by educational attainment by employment status for the population 16 to 19.

PCT23 Sex by school enrollment by age for the population 3 years and over.

PCT24 Sex by college or graduate school enrollment by age for the population 15 years and over.

Appendix A Continued

2) Current Population Survey (CPS) Data

U.S Census Bureau conducts interviews for monthly Current Population Survey (CPS) and school enrollment data of households' members 3 years old and over is obtained from CPS. This data gives annual enrollments for all the school and colleges in United States. Data is available by sex, age, race, type of school and type of college. The data can be used to study the trip attraction of schools and colleges based on the variable number of students' enrollment. The dataset is easily available from the following link: http://www.census.gov/population/www/socdemo/school.html

3) American Community Survey (ACS)

The American Community Survey (ACS) is a nationwide survey started in January 2006. ACS is started to replace decennial census long form by providing annual (or multi-year average) estimates of selected social, economic, and housing characteristics of the population for many geographic areas and subpopulations. ACS gives school enrollment by age, sex, type of school and type of college for the population 3 years and over. 1 year and 3 year estimates of American Community Survey are easily available from the following link:

http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=ACS&_submenuId=datasets_1&_lang=en&_ts=

Appendix A Continued

A.2 Special Generator: Airports

FAA extracts passenger (enplanement) and cargo data from Air Carrier Activity Information System (ACAIS). This data is available only for Commercial Service Airports. Commercial Service Airports are publicly owned airports that have at least 2,500 passenger boardings each calendar year and receive scheduled passenger service. These airports are further classified into:-

1) Primary Commercial Service Airports (that have more than 10000 passenger boardings per year) and,
2) Non primary commercial service airports (that have at least 2,500 and no more than 10,000 passenger boardings each year).

Passenger boarding and all-cargo data is collected for a full calendar year and determines entitlements for the next full fiscal year (i.e., calendar year 2007 data determines Fiscal Year 2009 entitlement funds). The dataset is easily available from the following link:

http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/

A.3 Special Generator: Hospitals

American Hospital Association (AHA) annual survey is an online survey taken by more than 6500 AHA registered hospitals throughout the United States. This database is used for market research and health care industry analysis on hospitals. The database captures information like facilities provided, hospital utilization, beds, admissions etc on each hospital. The number of beds information in this data can be used for the trip generation as no. of beds best describes the trip generation for hospitals. This dataset is available at state and regional geographic level.

Appendix A Continued

This dataset is not available online and can be ordered in the form of CD and book. More information can be obtained using the following link: http://www.ahadata.com/ahadata/html/AHASurvey.html

A.4 Laredo Travel Demand Model

Laredo Travel Demand Model serves as an important tool for developing comprehensive multimodal transportation plan for the Laredo Metropolitan area. In Laredo travel demand model uses 2000 U.S Census Bureau for socio-economic data and Texas workforce commission 2003 for employment data. The special generators used in the Laredo travel demand model are Schools, College/University, Airports, Transit Center, Hospitals, Regional Shopping malls, Regional Sports facilities and Regional Parks. Trip generation for each special generator is modeled separately using linear regression analysis. The independent variables used for each special generator are as follows:

Table 26 List of Special Generators and Variables Used in Laredo Travel Demand Model

Special generator	List of variables
Schools, College /University	Number of Students Number of Staff
Airports	Number of Boardings Number of Deplaning Passengers
Transit Center	Annual Bus System Transfers
Hospitals	Number of Employees Number of Beds
Regional Shopping Malls	Number of Employees
Regional Entertainment/ Sports Facilities	Capacity of the Facility
Regional Parks	Acreage of the park Number of Visitors

Appendix A Continued

The data used for the linear regression analysis is obtained from the traffic counts and surveys conducted at the special generators.

A.5 Lincoln MPO Travel Demand Model

Lincoln travel demand model is used for the city of Lincoln-Lancaster County (Lincoln MPO). In Lincoln travel demand model, special generators are considered as land uses that do not generate or attract trips at the same rate as other land uses in the same land use category, hence they are assigned a unique trip rate. Nine special generators and the variables used to explain trip rates for these special generators used in Lincoln travel demand model are as follows:

Table 27 List of Special Generators and Variables Used in Lincoln MPO Travel Demand Model

Special generators	List of variables
Airports	Number of Employees
Prison	Number of Employees
Mall	Area (1000 Sq.ft)
Medical Center	Number of Employees
University Main Campus	Number of Students
Heavy Industrial	Area (acres)
Low Retail	Area (1000 Sq.ft)
Low Office	Area (1000 Sq.ft)
Low Service	Area (1000 Sq.ft)

Trip attractions for the internal non-residential land uses are estimated using a trip rate per unit (square feet, students, employees, etc.). These Non-Residential trip rates are obtained using "ITE Trip Generation, 7th Edition".

Appendix A Continued

A.6 Texas Travel Demand Model Package

Special generators are modeled separately using trip production and trip attraction rates for that generator. Major regional amusement parks, Major sports facilities, Major regional airports, Military bases, Colleges, universities, communities' colleges and High schools are considered as special generators in the Texas travel demand model. Special generator model requires more detailed information such as TAZ where it is located, number of hours in operation during a normal weekday, number of work shifts, and number of employees per work shift. All the data required for calculating trip attraction rates is obtained by conducting surveys at the special generators. Following variables are used by the linear regression models for each special generator:

Table 28 List of Special Generators and Variables Used in Texas Travel Demand Model

Special generators	List of variables
Military Base	Number of Employees
Schools, Colleges/Universities	Number of Students Enrolled
Hospitals	Number of Beds
Major Regional Airports	Number of Flights/ Day Number of Deplaning Passengers /Day

A.7 Dallas-Fort Worth Regional Travel Model (DFWRTM)

The modeling areas included in DFWRTM is the entire counties of Collin, Dallas, Denton, Rockwall and Tarrant, the western portion of Kaufman County, the northern portion of Ellis and Johnson Counties, and the eastern portion of Parker County. The employment types used in this model are Basic, Retail and Service. In DFWRTM, special generators and the variables used to explain trip rates are as follows:

Appendix A Continued

Table 29 List of Special Generators and Variables Used in DFWRTM

Special generators	List of variables
Regional Shopping Malls	Number of Employees
University/Colleges	Number of Employees
Hospitals	Number of Employees

The trips attracted by special generators are computed by applying the trip attraction rates to the employment at respective sites and adding extra increment trips associated with each category of special generator. The number of incremental trips for each special generator type is obtained by taking the difference of cross classification model generated trip rates and trip rates obtained from regional travel survey.

Appendix A Continued

A.8 Trip Attraction Rates of Shopping Centers (SCs) in Northern New Castle County, Delaware

Apart from ITE trip generation manual, this paper gives two possible approaches to calculate trip attraction for shopping centers. These two approaches are based on the survey of the movement patterns (No. of people visiting and No. of vehicles).

1) Macroscopic Approach:

In this approach, Trip attraction rate is a function of physical features of shopping centers like total parking space, total floor area, no. of stores and location of shopping center. ITE trip generation manual does not consider these physical features i.e. Phenomenon of trip chaining is not taken into account in ITE. ITE uses gross leasable area (in 1000 Sq.ft) as independent variable and average number of vehicle trips ends per one day to shopping center as dependent variable. The relationship between total parking space, total floor area, number of stores and trip attraction rate is obtained by regression analysis. Shopping centers are classified based on number of stores, number of parking, availability of supermarket and discount retail store. Based on the composition of the stores in the SC, they are classified into following 4 groups:

Type 1: This is a large SC with a large supermarket, a large discount retail store, one or two restaurants, a bank, and many small stores are located.

Type 2: This is a medium size SC where a medium sized supermarket, a medium sized discount retail store and many smaller stores are located.

Type 3: This is a small SC where one supermarket and several small stores are located.

Type 4: This is a collection of specialty stores, but does not include a supermarket or discount retail store.

Appendix A Continued

Data used in the linear regression analysis is obtained by conducting traffic counts survey for every 15 min interval at various sites of SCs on weekday, Saturday and Sunday. In macroscopic approach, two models are used as the variables used (number of stores, floor area and number of parking spaces) are highly correlated and convey the same information. Macroscopic models depend on the physical features and not the type of stores that is they are insensitive to the nature of stores.

2) Microscopic Approach:

In this approach, importance is given to each store in SC. The main objective here is to determine weights for trip attraction rates (TAR) of each store. The weighted sum of TARs of individual stores gives TAR of Shopping Center. TAR for different stores in a SC is obtained by conducting survey for 15 min interval. Stores are classified into major and minor based on the shares of each store and weight for each store is obtained using optimization technique. A major drawback of the microscopic model is the large volume of data that is required for calculation of the TAR of individual stores and the weights. The number of people entering individual stores needs to be collected for different time periods.

Appendix A Continued

A.9 A Comprehensive Planning and Design Manual for Park-and-Ride Facilities: Chapter 5 - Suburban Park-and-Ride Demand Estimation Techniques

A.9.1 Post Modeling Techniques

This technique is used for individual park and ride facilities and follows the traditional transportation modeling methodology. The steps involved in this modeling technique are as follows:-

1) Identify the production ends (home zones) and attraction ends (work zones) of the potential park and ride site.
2) Identify the various characteristics of attraction ends such as parking cost, availability, traffic congestion etc.
3) Determine total person trip interchange between the production zones and the attraction zones by using modal splits from the regional travel model or other data sources.
4) Determine the proportion of trip interchange for Park and carpool and Bus Park and ride users based on the characteristics of bus services and trip end density in attraction zones.
5) Estimate the number of parking spaces required at each site by developing trip interchange tabulations based on the park and ride demand share.

A.9.2 Direct Regional Forecasting Techniques

In this regional forecasting approach, park and ride trip is actually modeled as a chained trip directly within the regional modeling process. Here, utility functions are used as they provide a measure of the attractiveness of one mode relative to another.

Appendix A Continued

Multinomial logit modeling approach is used as the basic theory behind the approach is that travelers will choose the mode which is quickest and cheapest mode of travel. Probability of choosing mode i is given by:-

$$S_i = \frac{\exp\,(b^k * V_i + a_i)}{A_{j=1}\,\exp\,(b^k * V_j + a_j)}$$

where,

V_i = measurable level of service characteristics

b^k = coefficient of kth variable (travel cost or annual income etc)

a_j = modal constant for mode i

Along with decision to select park and ride versus the auto mode, commuter also decides on which park and ride lot to be used depending upon the traffic congestion conditions. The park and ride lots immediately upstream of traffic congestion tend to have high levels of demand. Logit coefficients for park and ride lots can be estimated using a trial and error approach, comparing estimates to observed occupancy and origin surveys until a level of accuracy is obtained.

A.9.3 Site Level Forecasting based on Site and Service Characteristics

This model is based on the theory that site attributes and service characteristics define the attractiveness of the site to potential users. Therefore, park and ride demand is estimated based on the attributes of the park and ride location. This model assumes that attractiveness of one mode over another can be estimated by measuring the differences in site and service attributes between competing modes.

Appendix A Continued

Site specific demand is heavily influenced by number of characteristics such as location of lot, service characteristics and availability of competing lots and perceived convenience of the facility.

A Park and Ride demand estimation study is done in the Greater Seattle metropolitan area for the King County Department of Metropolitan Services (Metro) on all-bus transit network. The park-and-ride facilities were examined for their existing demand characteristics and the draw area associated with the patrons accessing the lot. A 1993 vehicle license plate survey was used as the basis for geocoding the residential location of vehicles observed in each of the 31 lots. Addresses for each observed parked vehicle were generated via a license plate search with the Washington Department of Motor Vehicles. The coordinates of each vehicle accessing individual lots were compared to the coordinates of the lot being used and then plotted on a common scale. The resulting service area demand sheds for each lot were compared to generate a catchment area shape.

In general, this methodology is all about defining a service area (catchment area) for the park and ride facilities and then developing equations based on the lot attributes using multivariate regression analysis.

1) Defining the market catchment area for park and ride

It is defined based on the differences in parking costs, extent of transit network and perceived congestion in a region. Socioeconomic data can be collected for the defined catchment area and can be used to predict demand for the specific park and ride lot.

Appendix A Continued

The shapes of the catchment area having 50 and 85 % of the total observed users at each park and ride lot were considered. At the 85% user level, a parabolic shape nearly represents a catchment area of the lots. A circular pattern with a radial diameter of 2 to 2.5 miles, centered at the park and ride itself describes the average catchment area at the 50 % demand level. Individual market areas are smaller than standard market areas because of features such as lakes and mountains which reduces the likelihood of travel. Using this catchment area shapes, overlaps and gaps between the park and ride facility services can be determined. This will help us map coverage zones of each facility and locate areas of service duplication and poor service.

Appendix A Continued

2) Identifying the site level characteristics affecting park and ride demand

The variables that can affect the demand for park and ride facilities at site level are as follows:-

No. of AM peak period express buses trips to CBD, no. of AM peak period express buses trips to major employment centers other than CBD, ratio of out of pocket auto cost to transit costs, distance between park and ride lot and destination (CBD), total population within the 50 % catchment area of lot, % of lower middle and lower income households within the service area of lot, the average best schedule transit time between park and ride lot and destination, peak traffic on adjacent roadway facility, no. of home based work trips between market area and destination, employment demand measure at the destination, relative measure of congestion between lot and destination, age of park and ride lot, availability of priority treatments, safety characteristics of lot, provision of passenger shelter and amenities, transit Information, parking costs at the destination and park and ride lot access attributes.

Service area population was determined by plotting the catchment area over a map of the 1991 Puget Sound Regional Council's TAZ system. Assuming that population is evenly spread throughout each TAZ, visual estimates were made of the percent of TAZ included within the catchment area. Transit costs are calculated by averaging weighted transit cost and auto cost is estimated by averaging weighted parking costs and driving costs to the major activity centers.

Appendix A Continued

3) Site level demand estimation

The variables mentioned above can be used to develop a planning tool to estimate the demand potential for park and ride facilities. The park and ride demand model is shown by following equation:-

$$\text{Demand} = N + aAa + bBb + cCc \ldots\ldots+.zZz$$

where,

N = Constant, incorporating a measure of the minimum lot size.

A, B, C, Z = independent variables.

a, b, c, z = model coefficients to be estimated using least square method.

a, b, c, z = variable exponents estimates using a least square method.

The no. of variables to be used in the regression analysis are controlled by availability of data from past surveys and existing database and the potential ease of developing similar data for the evaluation of future lots. All the variables used should be independent of each other and mutual independence can be evaluated by constructing a correlation coefficient matrix for all variables.

Various PRD equations are developed based on the data items available and R-squared values are calculated to understand the percentage of variability in the data explained by the model. The demand obtained represents both transit-oriented and non-transit-oriented (e.g., carpool) demand for park-and-ride spaces. The proportion of trip interchange for Park and carpool (Non-transit) and Bus Park and ride (Transit) users is determined based on the characteristics of bus services and trip end density in attraction zones.

Appendix A Continued

This PRD model cannot be directly transferred to other regions. The two options available to transfer the PRD model to another location are as follows: - Estimate a new PRD model, estimating the coefficients for each of the variables used in the several PRD equations, or validate the Seattle PRD equations, developing a correction factor that compensates for the inherent differences between the region being studied and the Seattle metropolitan area.

Appendix A Continued

A.10 Application of a Park-and-Ride Forecasting Procedure in the Greater Vancouver Transportation Model

The regional transportation model being a nested logit choice model, Park and Ride was treated as a sub mode of transit in nested logit structure. The Park and Ride impedance was computed as the sum of auto impedance from origin to Park- and Ride and the transit impedance from Park- and Ride to the destination along with the weights and sub-modal biases applied to the park and ride trips. Also, the catchment areas at origin and destination ends were identified to avoid the creation of illogical trip chains. Modeling of several park and ride sites competing for same potential users is complex but can be effectively and efficiently achieved using the matrix convolutions.

Assumptions on which the Park and Ride model is based:

1) Transit riders with abundant free parking will not use Park and Ride.
2) If transit impedance from origin to destination zone is lower than that from park and ride lot to their destination, trip makers will not use Park and Ride.
3) The generalized cost of park and ride will include parking charges and penalty representing the uncertainty of finding a parking place where demand exceeds the capacity.
4) Trip makers will be reluctant to use Park and ride if travel time and cost saved is less as compared to auto.
5) To match the observed distribution of origins of park and ride trips, it was necessary to apply weight to the auto leg of the trip. This weight is dependent on transit mode served by park and ride.

Appendix A Continued

6) The effective transit impedance for trip makers using park and ride will be lower than for trip makers with no access to park and ride.

The procedure to consider park and ride lots in travel model has following steps:-

1) Compute Auto and Transit impedances for all dummy zones pairs representing park and ride sites.

2) Compute park and ride impedance using minimum path based on

$$\text{MIN PRI}_{(ij)} = \text{Minimum}\left(AI_{(ik)} * W^{km} + TI_{(kj)} + P^{km} + SP^{k}\right)$$

where,

i = Origin

j = Destination

k = Park and Ride site.

MIN $PRI_{(ij)}$ is the minimum park and ride impedance for all logical path i-k-j.

$AI_{(ik)}$ is the Auto Impedance from i to k including any parking charge collected at k.

W^{km} is an Auto Impedance weight applied to all trips to k

$TI_{(kj)}$ is the transit impedance from k to j.

P^{km} is a penalty or modal bias applied to all trips to k. It depends on transit mode (m) served by k.

SP^{k} is an additional penalty applied to all trips to k to ensure that parking demand does not exceed the available capacity.

Appendix A Continued

3) Calculate enhanced transit impedance for origin destination with access to park and ride using:-

$$ETR\ (ij) = (\ln (\exp (-\beta * TI_{(kj)}) + \exp (-\beta * PRI_{(ij)})))/ (-\beta)$$

Where,

ETR (ij) is the enhanced transit impedance.

β is the calibrated exponent used in the park and ride sub mode split logit model.

4) Run the distribution and auto/ transit mode split using ETR (ij) as the transit impedance.

5) Split forecast choice transit trips into walk and park and ride access modes using logit function

6) Compute park and ride impedance for each logical path based on:-

$$PRI_{(ij)} = AI_{(ik)} * W^{km} + TI_{(kj)} + P^{km} + SP^{k}$$

7) Distribute forecast park and ride trips among competing park and ride lots based on following multinomial logit function:

$$PRT_{(ij)} = PRT_{(ij)} * \exp (-\beta * PRI_{(ij)}) / \Sigma_{(k)} (\exp (-\beta * PRI_{(ij)}))$$

8) After comparing the transit impedance with estimated peak hour capacity of parking lot, recalculate MIN $PRI_{(ij)}$ and $PRT_{(ij)}$ for all k.

9) Repeat split forecast choice transit trips and comparing transit impedance steps until demand at overloaded lots converge almost equal to capacity.

10) Separate forecast park and ride trips into auto and transit trips components.

11) Add auto leg of park and ride trips to the auto trip matrix and add the transit leg of park and ride trips to transit trip matrix. Assign auto and transit trips

Appendix A Continued

A.11 Intermodal Terminals

This step of the freight carrier modeling process estimates the average total freight trips by mode that would be generated by the planned facility for a specific time period (daily, annual, etc.). The total trips generated by the facility include both production, originating from the facility, and attraction, destined to the facility, trips. The most common methods used for facility trip generation include trip generation rates, regression equations, and surveys. Using trip generation rates is the simplest approach for trip generation, in which estimates of number of trips per employee are applied to the target facility to estimate the total trips generated. Trip generation rates also can vary based on truck types and the type of facility (land use). The trip generation rates used in this approach can be derived from previous surveys of freight flows associated with similar facilities or from standard sources providing average trip generation rates for facilities, based on facility and truck types.

The use of regression equations for trip generation offers the ability to predict the total trips generated as a function of more than one facility variable, which makes this approach potentially more robust and reliable compared to the use of trip generation rates. For example, a regression equation predicting total daily freight trips as a function of land use category, number of employees, and building/floor area. However, caution should be maintained when developing and using regression equations for trip generation, as equations with statistical inconsistencies will not result in reliable estimates.

Appendix A Continued

Conducting surveys is the most time- and cost-intensive approach for trip generation, but it can provide the most accurate results, compared to trip generation rates and regression equations. This approach is useful in the case of special trip generators such as intermodal terminals, in which trip generation estimates are derived through direct contacts with a limited number of firms (facility operators and users – truck companies, shippers, etc.). This approach is particularly effective if the planning agency has been building contacts with the freight community over a longer period of time.

Appendix A Continued

A.12 Discount Superstore Trip Generation

This study aims at developing trip rates which truly represents the trip generation characteristics of discount superstores like Wal-Mart. To achieve this, a national discount superstore trip generation study was conducted by Texas Transportation Institute (TTI). An unbiased sample of 32 study sites was randomly selected from the 828 stores in original sample. The original sample was selected based on the following selection criteria:

1) Standard superstores (i.e., stores may or may not contain lube and tire centers and/or garden centers)
2) Located in a standard metropolitan statistical area (MSA).
3) At least two years old.
4) Free-standing stores that could be isolated to perform an accurate count of inbound and outbound vehicles.
5) No construction, special promotions, or events at the store.

Once the sites were selected, the study consisted of following steps:

1) Collecting site and trip generation data at 32 stores for the typical season during September to mid-November and also the peak season (Thanksgiving and week prior to Christmas) with the help of trained supervisors.
2) Analyze data to determine trip generation rates or equations for both typical and peak seasons.

Appendix A Continued

Trip generation rates obtained using the survey data varied between individual superstores. Rates were developed using Gross Floor Area (GFA) as an independent variable. GFA data was obtained from an architecture firm. The results show that the rates obtained from the national study are higher than the ITE trip rates, but the differences are not statistically significant except for the Sunday daily rate. The study concludes that high degree of variability and small numbers of observations in the ITE data are the reasons for this difference in the trip rates.

Appendix A Continued

A.13 Transit Impact Fee Analysis: Technical Memorandum #2 Land Use and Trip Generation Rates

This study is all about exploring land uses that might be incorporated into an expanded Transit Impact Development Fee (TDIF) and describing trip generation rates associated with these land uses for the San Francisco planning department. Based on the preliminary assessment of potential transit trip generation for each land use, following land uses categories were identified as potential candidate for generating high number of transit trips:

1) Office
    a. Professional/Business Office
    b. Professional Design Office
2) Lodging
    a. Hotel/Motel
3) Institutions
    a. Hospital, medical center
    b. Social/charitable service
    c. Child care facility
    d. Elementary/Secondary/Post-secondary school
    e. Churches or other religious institution
4) Community Facilities
    a. Community Club House
    b. Community Cultural center

Appendix A Continued

5) Assembly and Entertainment
    a. Theatres
    b. Recreation Building
    c. Amusement Enterprise and parks/Citrus/Carnival
    d. Open air Stadium or arena
6) Commercial (Retail)/ Personal Services
    a. Local Oriented retail
    b. Regional retail
    c. Bar
    d. Full-service restaurant
    e. Financial Services
7) Manufacturing and Processing
    a. Light Manufacturing-assembly, packing, repair, processing
    b. Light Food Processing

The trip rates for the above land uses are obtained from the following sources:

1) San Francisco Interim Transportation Impact Analysis Guidelines for Environmental Review, Interim Edition, January 2000, The Planning Department City and County of San Francisco.
2) Trip Generation, 6th Edition, Institute of Transportation Engineers
3) Citywide Travel Behavior Survey, Employees and Employers, may 1993, San Francisco Planning Department, San Francisco Public Utilities Commission, and San Francisco County Transportation Authority.

Appendix A Continued

A.14 Quantifying Special Generator Ridership in Transit Analyses

The authors aim at developing an analysis process for analyzing the impact of special generators on transit services in Denver area. The study area is "Gold Line" — a freight rail corridor between downtown Denver and Golden, Colorado. According to the authors, there are three types of special generators:-

1) Regular special generators are those special generators that produce trips on a regular, weekday basis. Examples: - airports, regional shopping centers, hospitals and schools.
2) Periodic special generators are those generators that do not produce trips on a regular weekday basis. Examples: - convention centers, stadia and arenas, fairs and festivals.
3) Special special generators include those sites or activities that cannot be easily classified as regular or periodic special generators.

This paper focuses on impact evaluation of periodic special generators. In the analysis process, generators having 500,000 attendees annually or 8,000 average individual event attendees were only considered. If a generator did not meet the size criteria, it was merged with other events occurring at same place.

Appendix A Continued

The trip generation model was developed for the periodic special generators:-

A.14.1 Trip Generation

This model is based on the attendance projections, which can be estimated from the past history of the attendance for a particular type of generator. The trips are also allocated to trip purposes. For events on weekdays, the trips were split between home based non work and non home based trip purposes and for events on weekends, all trips are taken as home based non work trips. Trip generation analysis is done on daily basis for all the periodic special generators. The annualization factor is total number of events days in a year. The trip generation results for the year 2015 for various special generators are obtained using the model. The annual growth factors are obtained based on the information from the operators of the special generators.

A.14.2 Trip Distribution

Home-based non-work and non-home-based trip attractions and non-home-based trip productions are estimated for the periodic special generators. Trip distribution of periodic special generators is simply a proportioning of trips from all parts of the region to a single site (for each periodic special generator). The basis for the proportioning mainly depends on the characteristics of each periodic special generator. The distribution of trips to and from the periodic special generators is made using a gravity model formulation. The gravity model is typically used to distribute trips from one origin to all destinations, not from one destination (i.e., the special generator) to all origins. However, the model can be applied in either direction.

Zonal home-based non-work or non-home based productions are used along with the periodic special generator attractions for the generator. The distribution for each periodic special generator is independent of other generator. The results for both the distributions are obtained- one for home-based non-work trips and one for non-home-based trips.

A.14.3 Mode Choice

Mode Choice is dependent on numerous items including auto and transit travel times and costs. Mode choice model is used for home based non-work and non-home-based trips. To simplify the mode choice procedure, trips obtained from trip distribution step are multiplied by the appropriate annualization factor. Several changes were made to the model in order to replicate base mode shares. The average event parking costs at the attraction zone was coded for each periodic special generator. The parking costs are adjusted to account for the average auto occupancy noted for each event.

A.14.4 Transit Assignment

Annual transit assignment is performed due to following reasons:

1) Each periodic special generator has a unique annualization factor.
2) This procedure eliminates the need to perform separate transit assignments for each special generator.

This step gives the annual periodic special generator boardings.

Appendix A Continued

A.15 WACOG Connector Program Transit Feasibility and Implementation Plan

The main purpose of this report is to estimate potential transit demand between Bullhead City, Kingman, and Lake Havasu City in Arizona by examining transit dependent population and other potential riders. Arkansas Public Transportation Needs Assessment (APTNA) method and Survey Research method were used to develop an intercity transit demand model. Transit demand is obtained by applying trip rates to the transit dependent population groups (elderly persons ages 60 and over, persons with disabilities under age 60, and persons living in poverty under age 60) in the APTNA method. The % of this population groups is obtained from the Arizona State Transit Needs Study. The frequency of the use of transit by different population groups mentioned above is obtained by the survey research method.

A.15.1 Trip Production

Based on the production and attraction between cities, gravity model was used to determine the intercity transit travel demand. The trip production for each city is calculated by multiplying the frequency of the use of transit by different population groups with the percentage of their respective population that uses transit.

A.15.2 Trip Attraction

Firstly, various trip purposes (medical, education, employment, recreation and county services) for which the trips are attracted are identified. Then, the proportion of trips attracted by these purposes (services) for the transit dependent population is obtained for each city.

Appendix A Continued

The annual trips by transit is obtained for medical services based on the number of beds in the hospital, for education services based on the number of enrollments in the college. The trips attracted by employment are obtained based on the labor force data for that year. Finally, the total intercity transit trips are calculated using the gravity model.

Appendix A Continued

A.16 Sketch Model to Forecast Heavy Rail Ridership

The purpose of this paper is to study ridership potential for heavy rails by developing a model that considers variables related to area surrounding the station. A multivariate linear regression model was created only for non-CBD stations using current ridership data collected for all 474 U.S heavy rail transit stations for the years 2004-2006. The demographic information for both areas surrounding the stations and entire metropolitan area was obtained from the respective MPOs. Model was developed using data from following ten cities: - Baltimore, Boston, Chicago, Cleveland, Los Angeles, Miami, New York (PATH train), Philadelphia, San Francisco, and Washington, DC. Exclusive regions around each station were used so as to avoid double counting of population and employment around station areas. Various independent variables related to station area demographics, station – specific transportation attributes, corridor demographic characteristics and metro area demographics were tested in the model. Along with the independent variables, the natural logarithm of the independent variables was also tested. The Person Product Moment was used to test possible linear correlations and Spearman's nonparametric coefficient was used to test possible non-linear correlations between independent and dependent variables. The results show that best predictor of actual boarding is employment and transit service characteristics are the best predictors of natural logarithm of boarding.

Following variables turned out to be statistically significant and important predictors:-

A.16.1 Binary Variables

1) 1 if this is a terminal station,0 if not
2) 1 If this station is a secondary downtown, 0 if not
3) 1 if this is a special transit attractor station, 0 if not
4) 1 if there is parking available, 0 if not
5) 1 if there is connection to other rail modes, 0 if not

A.16.2 Continuous Variables

1) Distance to downtown, in miles
2) Midday headway in minutes
3) CBD density, in employees per square mile
4) Employment within 0.25 miles of the station
5) Employment within 0.25 to 0.5 miles of the station
6) Population within 0.25 to 0.5 miles of the station

The results show a positive and strong relationship between actual and predicted boarding for all 381 non-CBD stations. To evaluate the proposed lines or rail extensions, the results of the model are aggregated to route-level as well as city-level. The model performs better at the city level with an R-squared value of 0.814 as compared to R-squared value of 0.702 for the route level model. The model can be applied to other cities with similar characteristics based on the mean and standard deviations of the variables used in the model. Also model can be improved by considering the non-linear models.

Appendix A Continued

A.17 Direct Ridership Forecasting

Travel demand models do not consider changes in station level land use and transit service characteristics. So, direct ridership models are used to forecast transit patronage. Direct Ridership models have been used to evaluate and compare various variables influencing transit patronage. They are used for light rail [Sacremento regional transit (RT) & Salt Lake City (TRAX)], Commuter rail [Sonoma marin area rail transit (SMART)] and Heavy rail [Bay area rapid transit (BART).

Direct ridership models use multivariate regression analysis based on the local land use data and data obtained from boarding & alighting counts at all stations. 30 Variables related to population and income, employment, cost of travel, station characteristics, transit service characteristics and comparative auto and transit accessibility were used to discover combination of variables with stronger correlation with ridership. For BART, Ridership is a function of variables like sum of population and employment within ½ mile of station (POPEMP), population within station catchment area (POPCTCH), frequency of peak period feeder buses (BUS), number of station parking spaces (PARK), number of peak period trains (TRAINS) and Train vehicle type;1 = BART & 0 = Caltrain (TECH).

The two formulae's used are as follows:-

RIDERSHIP = 2.04 + 0.300 X POPEMP + 0.069 X POPCTCH + 0.560 X TRAINS + 1.787 X TECH

RIDERSHIP = 2.400 + 0.233 X POPEMP + 0.021 X POPCTCH + 0.287 X BUS + 0.038 X PARK + 0.477 XTRAINS + 1.576 X TECH

Appendix A Continued

Also, log log regression analysis was performed to estimate elasticity's of the above mentioned variables. Similarly, models are used to obtain variables affecting commuter and light rail trains ridership.

Appendix B: Results of the Exploratory Analysis Performed for the Enhancement of Trip Attraction Capability

Table 30 Total Employment, Trips Generated by Employment, Trips Generated Using Trip Rates, Area of Non-Residential Land Uses and Special Generators for the Stops in all the Four Routes.

Sr. no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
1	F1	5000 Susquehanna St.	2,612	3,531.00	590.72	83.27	20.69	35917	0	0
2	F1	Edgewood Ave. & Shenandoah Ave.	2,345	3,211.60	576.06	82.06	15.07	32357	0	0
3	F1	Edgewood Ave. & Chenago Blvd.	2,062	2,868.80	531.57	81.47	1.39	30473	0	0
4	F1	2626 W Edgewood Ave.	2,031	2,826.00	451.52	84.02	5.32	24343	0	0
5	F1	Edgewood Ave. & Edward St.	209	285.20	440.04	54.29	11.04	41160	0	0
6	F1	12th St. & West Palm Ave.	213	294.00	403.63	37.29	33.54	34506	0	0
7	F1	3120 12th St.	80	110.60	121.95	10.26	0.97	8311	2996	1
8	F1	12th St. & Melson Ave.	7	9.00	70.01	677.89	6.84	2996	2996	1
9	F1	12th St. & Prospect St.	9	11.80	70.01	493.31	4.89	2996	2996	1
10	F1	12th St. & Detroit St.	83	116.20	0.00	100.00	6.70	0	0	0
11	F1	Detroit St. & 10th St.	31	42.60	0.00	100.00	2.90	0	0	0
12	F1	Detroit St. & 8th St.	92	128.00	0.00	100.00	7.15	0	0	0
13	F1	Detroit St. & 6th St.	99	137.40	462.14	236.35	7.23	8024	7058	1
14	F1	Detroit St. & 5th St.	96	133.20	761.52	471.71	8.89	10949	9983	1
15	F1	Detroit St. & 1st St.	17	23.80	39.61	66.43	6.16	4505	0	0
16	F1	Detroit St. & Detroit Cir.	84	113.40	39.61	65.07	6.26	4505	0	0
17	F1	Detroit St. & Commwealth Ave.	116	158.20	136.36	13.81	2.67	7710	0	0
18	F1	Detroit St. & Lowell Ave.	121	165.20	38.39	76.76	1.58	4205	0	0
20	F1	Detroit St. & Broadway Ave.	162	224.80	758.60	237.46	4.41	31501	5220	1
21	F1	Broadway Ave. & St. Clair St.	132	182.80	1,755.71	860.45	4.59	193535	5220	1
22	F1	Broadway Ave. & Huron St.	105	143.80	635.68	342.06	0.95	114112	0	0
23	F1	Broadway Ave. & Superior St.	187	249.60	312.42	25.17	4.55	40893	0	0
24	F1	2606 Broadway Ave.	174	231.60	494.39	113.47	1.78	29116	0	0
25	F1	Broadway Ave. & McDuff Ave.	253	330.80	1,142.54	245.39	6.41	67193	0	0
26	F1	McDuff Ave. & Beaver St.	299	392.00	1,185.59	202.45	9.65	79272	0	0
27	F1	McDuff Ave. & Strickland St.	361	477.40	1,187.25	148.69	0.34	85453	0	0
28	F1	McDuff Ave. & Warrington St.	275	370.40	141.82	61.71	5.29	12311	0	0
29	F1	McDuff Ave. & Fitzgerald St.	282	378.00	299.49	20.77	0.00	15979	3668	1
30	F1	2978 Fitzgerald St.	279	379.00	327.62	13.56	15.16	20010	3668	1
31	F1	Fitzgerald St. & Willow Branch Ave	296	398.60	388.32	2.58	5.45	25822	3668	1
32	F1	Fitzgerald St. & Cherokee St.	128	167.60	388.69	131.92	4.17	25924	3668	1
33	F1	McCoy Creek Blvd. & Sunshine St.	26	31.60	173.43	448.83	0.43	19614	0	0
34	F1	McCoy Creek Blvd. & Leland St.	146	203.80	438.87	115.34	1.79	25896	0	0
35	F1	McCoy Creek Blvd. & King St.	182	254.40	438.87	72.51	7.75	25896	0	0
36	F1	McCoy Creek Blvd. & Nixon St.	189	260.40	515.61	98.01	1.06	31295	0	0
37	F1	Forest St. & Stockton St.	155	196.40	476.03	142.38	4.17	64917	0	0
38	F1	Forest St. & Woodlawn Ave.	277	367.20	719.62	95.97	0.92	134932	0	0
39	F1	Forest St. & Claude St.	328	437.60	1,051.14	140.21	1.56	178650	33368	1
40	F1	Forest St. & Copeland St.	563	763.00	935.74	22.64	4.38	162111	33368	1
41	F1	Forest St. & Goodwin St.	539	737.00	1,088.74	47.73	0.00	208788	33368	1

Appendix B Continued

Table 30 Continued

Sr. no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
42	F1	Forest St. & Park St.	1,292	1,719.00	1,431.93	16.70	0.00	98933	0	0
43	F1	Park St. & Price St.	1,552	2,085.00	1,091.68	47.64	7.86	85497	0	0
44	F1	Park St. & Jackson St.	1,376	1,908.80	526.34	72.43	1.92	36306	0	0
45	F1	Water St. & Jefferson St.	7,589	10,480.20	1,965.25	81.25	0.47	63289	0	0
46	F1	550 Water St.	9,692	13,316.20	7,647.36	42.57	0.18	235222	0	0
47	F1	Pearl St. & Water St.	12,182	16,730.40	8,032.69	51.99	2.09	251492	0	0
48	F1	Forsyth St. & Julia St.	23,225	32,174.00	16,677.95	48.16	0.55	577605	4874	1
49	F1	Forsyth St. & Laura St.	23,728	32,561.20	40,412.44	24.11	3.82	1524033	11685	1
50	F1	Forsyth St. & Ocean St.	22,410	30,714.80	30,244.94	1.53	0.48	1206460	11735	1
51	F1	Newnan St. & Adams St.	8,691	11,727.20	22,189.02	89.21	5.82	913534	11735	1
52	F1	Newnan St. & Duval St.	7,492	10,066.40	28,922.68	187.32	0.53	1185923	73981	1
53	F1	Ocean St. & Beaver St.	16,854	23,203.00	39,435.49	69.96	1.92	1607201	62246	1
54	F1	F.C.C.J. Station	14,456	20,197.20	30,239.71	49.72	101.53	1295519	85440	1
55	F1	Church St. & Newnan St.	6,226	8,313.00	27,222.83	227.47	0.05	1087644	52995	1
56	F1	Newnan St. & Ashley St.	5,878	7,836.80	29,862.56	281.06	1.43	1096236	69107	1
57	F1	Newnan St. & Brown St.	5,660	7,530.40	20,494.71	172.16	0.00	753088	69057	1
58	F1	Newnan St. & Ashley St.	5,467	7,280.60	7,643.59	4.99	0.46	327235	62246	1
60	F1	Beaver St. & Ocean St.	6,338	8,491.00	31,117.96	266.48	1.32	1329482	80566	1
61	F1	Beaver St. & Market St.	2,215	2,999.80	2,452.71	18.24	34.00	195657	62246	1
62	F1	Union St. & Cemetery St.	643	839.00	455.33	45.73	0.41	46686	0	0
63	F1	Union St. & Palmetto St.	426	532.40	806.25	51.44	0.10	47529	4956	1
64	F1	Union St. & Spearing St.	428	535.80	1,266.67	136.41	0.15	63441	4956	1
65	F1	Union St. & A. Philip Randolph Bl	132	177.40	1,252.56	606.07	2.22	63571	4956	1
66	F1	Union St. & Van Buren St.	100	132.60	1,001.30	655.13	1.37	57897	4956	1
67	F1	Union St. & Franklin St.	109	144.00	1,036.95	620.10	0.88	64148	4956	1
68	F1	Franklin St. & Pippin St.	204	273.60	1,029.01	276.10	1.92	63278	4956	1
69	F1	Franklin St. & Odessa St.	249	326.20	2,928.91	797.89	2.10	128757	4956	1
70	F1	Franklin St. & Jessie St.	380	489.60	2,650.85	441.43	10.55	197328	0	0
71	F1	Franklin St. & Phelps St.	386	495.60	2,697.26	444.24	7.96	210349	0	0
72	F1	Franklin St. & E 1st St.	307	395.60	929.27	134.90	7.17	179032	1992	1
73	F1	1151 Franklin St.	484	635.80	1,088.93	71.27	1.71	212802	1992	1
74	F1	Franklin St. & E 3rd. St.	490	641.00	1,316.07	105.32	3.42	283968	1992	1
75	F1	Franklin St. & E 4th St.	381	516.60	980.18	89.74	2.92	189719	1992	1
76	F1	4th St. & Milnor St.	371	502.60	980.18	95.02	2.48	189719	1992	1
78	F1	Milnor St. & 5th ST	508	698.80	544.18	22.13	4.26	73599	2162	1
79	F1	1701 7th St.	514	715.40	880.26	23.04	2.63	59680	2162	1
80	F1	7th St. & Florida Ave.	454	625.60	986.57	57.70	0.00	67051	2162	1
81	P7	Herlong Rd & Fouracker Rd	51	69.80	148.28	112.44	26.42	15928	0	0
82	P7	Fouracker Rd & La Trec Dr	301	418.80	136.29	67.46	0.85	14929	0	0
83	P7	Fouracker Rd & Renoir Dr	629	830.00	1,277.33	53.90	1.41	25732	0	0
84	P7	Fouracker Rd & Normandy Bvld	874	1,127.60	1,211.54	7.44	10.19	9755	0	0
85	P7	7952 Normandy Blvd	1,125	1,429.00	1,876.29	31.30	5.98	12749	6339	1
86	P7	Normandy Bl & Normandy Village Pwy	679	831.20	665.26	19.96	3.68	7759	6339	1

Appendix B Continued

Table 30 Continued

Sr. no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
87	P7	Normandy Blvd & Memorial Pkwy	572	743.60	3,759.36	405.56	8.06	54825	12871	1
88	P7	7016 Nomandy Blvd	400	501.80	4,026.77	702.47	2.46	70264	12871	1
89	P7	Normandy Blvd & La Marche Dr	629	764.80	185.53	75.74	13.52	8100	0	0
90	P7	Normandy Blvd & Granville Rd	489	606.80	231.11	61.91	2.98	10626	0	0
91	P7	Normandy Blvd & Lane Ave	863	1,079.60	2,594.19	140.29	13.60	79069	2776	1
92	P7	Normandy Blvd & Verna Blvd	733	942.80	2,413.66	156.01	7.31	73983	2776	1
93	P7	Normandy Blvd & Fountain Rd	675	884.60	2,997.47	238.85	1.31	79049	67734	1
94	P7	Normandy Blvd & Ellis Rd	473	628.20	3,020.04	380.74	2.74	81521	67734	1
95	P7	5476 Normandy Blvd	492	648.20	3,248.53	401.16	6.72	130831	67734	1
96	P7	5320 Lenox Ave	1,093	1,398.40	3,653.32	161.25	2.15	166109	86475	1
97	P7	Lenox Ave & Verna Rd	885	1,131.60	2,477.45	118.93	4.23	73353	51633	1
99	P7	Lenox Ave & Garth Ave	621	795.00	2,288.45	187.86	2.47	91689	19950	1
100	P7	Lenox Ave & Cassat Ave	649	818.60	2,524.82	208.43	6.92	116428	19950	1
101	P7	Cassat Ave. & Lenox Ave	786	1,027.20	1,952.83	90.11	0.47	125458	2524	1
102	P7	4782 Lenox Ave	1,072	1,401.40	1,510.29	7.77	0.27	113957	5381	1
103	P7	Lenox Ave & Edgewood Ave	969	1,260.00	1,467.59	16.48	15.07	110948	5381	1
104	P7	Edgewood Ave & Roselyn St	703	942.80	1,390.42	47.48	3.42	105990	5381	1
105	P7	Edgewood Ave & College St	335	432.20	1,751.02	305.14	2.33	56848	33624	1
106	P7	Post St & Cypress St	409	526.40	1,562.85	196.89	16.12	50493	36121	1
107	P7	Post St & Nelson St	189	240.80	860.10	257.18	4.72	19760	15067	1
108	P7	Post St & Brierfield Dr	119	158.40	41.33	73.91	2.64	7039	0	0
109	P7	Post St & Day Ave	136	179.40	437.43	143.83	7.22	20498	2745	1
110	P7	Post St & Shearer Ave	266	331.00	664.42	100.73	0.95	28863	2745	1
111	P7	Post St & Plymouth St	315	393.80	1,930.53	390.23	13.08	45168	2745	1
112	P7	Post St & Willow Branch Ave	399	501.40	1,862.36	271.43	7.06	35607	3545	1
113	P7	Post St & Cherry St	178	232.40	1,301.16	459.88	7.96	18577	800	1
114	P7	Post St & James St	224	288.80	186.15	35.54	0.59	8388	0	0
115	P7	Post St & King St	375	476.80	405.76	14.90	8.73	20916	0	0
116	P7	Post St & Acosta St	476	620.40	642.37	3.54	1.75	36505	5741	1
117	P7	Post St & Barrs St	705	929.20	605.82	34.80	0.91	45946	0	0
118	P7	Post St & Stockton St	702	928.40	949.12	2.23	5.87	50143	3438	1
119	P7	Post St & Osceola St	659	863.20	856.64	0.76	0.56	63845	658	1
120	P7	Post St & Copeland St	1,219	1,614.00	1,197.84	25.78	1.66	166761	0	0
121	P7	Post St & Goodwin St	1,179	1,571.40	3,271.11	108.17	0.22	202950	13397	1

Appendix B Continued

Table 30 Continued

Sr .no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
122	P7	Post St & Margaret St	1,579	2,111.00	3,776.85	78.91	5.60	206922	23136	1
123	P7	Park St & Riverside Pk	1,666	2,215.20	7,524.16	239.66	5.35	187129	23136	1
124	P7	Park St & Roselle St	5,913	8,161.20	5,887.74	27.86	2.44	186705	9739	1
125	P7	Park St & Edison Ave	5,577	7,710.60	1,938.55	74.86	0.83	102374	0	0
126	P7	Park St & Price St	1,552	2,085.00	1,091.68	47.64	5.01	85497	0	0
127	P7	Park St & Jackson St	1,376	1,908.80	526.34	72.43	2.61	36306	0	0
128	P7	Park St & Stonewall St	2,973	4,147.80	331.20	92.02	0.62	28391	0	0
129	P7	Water St & Jefferson St	7,601	10,492.80	1,965.25	81.27	0.58	63289	0	0
130	P7	Pearl St & Bay St	12,182	16,730.40	8,032.69	51.99	3.11	251492	0	0
131	P7	Forsyth St & Laura St	21,817	30,207.80	39,499.54	30.76	4.29	1424034	11685	1
132	P7	Forsyth St & Ocean St	22,763	31,202.00	30,342.72	2.75	0.43	1214902	11735	1
133	P7	Newnan St & Adams St	8,483	11,436.00	22,237.49	94.45	7.52	916345	11735	1
134	P7	Newnan St & Monroe St	7,859	10,565.80	28,809.63	172.67	0.32	1179367	73981	1
135	P7	Newnan St & Ashley St	5,878	7,836.80	29,862.56	281.06	2.26	1096236	69057	1
136	P7	Beaver St & Ocean St	6,318	8,463.00	31,117.96	267.69	4.78	1329482	80566	1
137	P7	Beaver St. & Laura St.	16,248	22,368.40	39,603.70	77.05	0.53	1636111	57869	1
138	P7	Beaver St. & Julia St.	15,128	21,111.80	25,083.70	18.81	0.86	1165508	52995	1
139	P7	F.C.C.J. Station	4,158	5,771.60	23,832.59	312.93	136.80	1066290	52995	1
140	P7	State St. & Julia St.	1,547	2,123.20	10,774.65	407.47	5.85	591368	52995	1
141	P7	Pearl St & 1st St	1,099	1,514.40	1,164.02	23.14	2.91	31574	0	0
142	P7	Pearl St & 4th St	1,260	1,757.80	967.65	44.95	0.65	64440	0	0
143	P7	Pearl St & 5th St	2,475	3,456.80	1,178.45	65.91	1.29	70875	0	0
144	P7	Pearl St & 6th St	1,335	1,858.60	2,170.70	16.79	2.95	58276	13424	1
145	P7	Pearl St & 8th St	1,671	2,329.20	2,297.75	1.35	0.13	78035	19349	1
146	P7	8th St Perry St	2,947	4,112.40	1,710.18	58.41	1.15	49330	14726	1
147	P7	8th St Boulevard St	4,372	6,078.00	1,218.70	79.95	14.52	45306	15986	1
148	P7	8th St. & Illinois St.	4,290	5,963.20	431.10	92.77	0.00	18296	8059	1
149	P7	8th St. & James Hall Dr.	3,056	4,240.60	94.86	97.76	34.56	5743	5743	1
150	P7	8th St. & Venus St.	2,807	3,892.00	94.86	97.56	9.03	5743	5743	1
151	P7	8th St. & Francis St.	334	456.20	213.05	53.30	0.00	15855	13906	1
152	P7	Davis St. & 8th St.	2,904	4,025.40	243.17	93.96	0.02	17764	17764	1
153	P7	Davis St. & Reiman St.	1,745	2,404.00	31.14	98.70	0.33	1885	1885	1
154	P7	Davis St. & 11th St. W	107	136.00	79.47	41.57	0.41	4688	1885	1
155	P7	Davis St. & 13th St.	122	160.60	114.34	28.80	0.43	8507	1885	1
156	P7	Davis St. & Lincoln Ct.	127	167.60	156.04	6.90	4.50	13075	1885	1
157	P7	Davis St. & 17th St. W	88	113.60	86.60	23.77	0.00	9486	0	0

Table 30 Continued

Sr. no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
158	P7	18th St. & Venus St.	53	65.00	86.60	33.23	0.42	9486	0	0
159	P7	18th St. & Jupiter St.	72	91.40	505.01	452.53	1.11	14867	3826	1
160	P7	18th St. & Flanders St.	72	95.20	708.42	644.14	0.76	18593	7517	1
161	P7	Boulevard St. & 18th St.	140	185.00	1,282.80	593.41	4.18	37079	7517	1
162	P7	21st St & Boulevard St	46	61.40	1,450.13	2,261.78	2.47	47151	7517	1
163	P7	21st St & Saturn Ave	31	42.60	628.82	1,376.10	0.43	14739	7517	1
164	P7	21st St & Brentwood Ave	36	49.20	505.01	926.44	4.73	14867	3826	1
165	P7	21st St & Davis St	31	42.20	565.40	1,239.81	0.05	18971	3826	1
166	P7	Davis St & 23rd St	52	69.60	138.93	99.61	1.23	11326	0	0
167	P7	Brick Rd & 25th St	43	57.00	97.23	70.58	0.41	6758	0	0
168	P7	Brick Rd & 27th St	52	67.00	716.70	969.70	7.30	15992	11123	1
169	P7	Brick Rd. & 28th St.	123	156.00	649.69	316.47	1.04	12545	11123	1
170	P7	Brick Rd & 30th St	174	226.20	1,512.26	568.55	0.94	18764	16030	1
171	P7	30th st. & Brick Rd.	167	221.40	1,512.26	583.04	0.81	18764	16030	1
172	P7	Golfair Blvd & Brentwood Av	208	274.00	3,042.30	1,010.33	1.10	39320	24304	1
173	P7	Brentwood Ave & Woodbine St	219	289.40	3,012.97	941.11	4.94	38041	24304	1
174	P7	Brentwood Ave & Alder St	296	398.60	2,794.33	601.04	0.45	38490	21633	1
175	P7	4731 Norwood Ave	919	1,175.00	1,244.96	5.95	0.86	19072	0	0
176	P7	5030 Norwood Ave	969	1,239.00	1,225.96	1.05	1.01	17432	0	0
177	P7	Gateway Mall	826	1,044.20	101.83	90.25	61.53	7933	0	0
178	P7	5839 Norwood Ave	837	1,050.40	49.66	95.27	5.60	4418	0	0
179	P7	Norwood Ave & Crestwood St	235	308.00	612.91	99.00	2.57	17432	0	0
180	P7	Norwood Ave & Lynton St	279	368.20	654.19	77.67	0.73	20229	0	0
181	P7	Norwood Ave & Laurel St	219	284.80	657.88	131.00	1.42	20435	0	0
182	P7	Norwood Ave & Essex St	191	247.00	492.13	99.24	0.83	12693	0	0
183	P7	Norwood Ave & Carrollton Rd	176	227.20	217.59	4.23	3.38	11865	6121	1
184	P7	Dunn Ave & Regency Dr	1,008	1,256.20	7,978.22	535.11	16.67	73893	0	0
185	P7	1057 Dunn Ave	932	1,166.80	5,608.19	380.65	2.84	13264	0	0
186	P7	Dunn Ave & Bonnelly Dr	1,120	1,400.60	3,741.66	167.15	3.20	27636	19848	1
187	P7	1275 Dunn Ave	857	1,072.80	5,231.78	387.68	8.15	96098	77521	1
188	P7	Dunn Ave & Biscayne Blvd	589	754.20	5,323.79	605.89	4.25	104934	86513	1
189	P7	Highlands Library	395	528.60	153.76	70.91	0.99	7330	0	0
190	P7	Dunn Ave & Ray Greene Dr	360	479.60	246.75	48.55	3.36	15251	0	0
191	P7	Dunn Ave & Armsdale Rd	263	362.40	523.25	44.38	0.86	27554	6205	1
192	P7	Dunn Ave & E Pine Estates Rd	228	313.60	477.27	52.19	1.04	24911	6205	1
193	P7	2445 Dunn Ave	155	209.60	245.82	17.28	0.52	20752	0	0
194	P7	Dunn Ave & Irma Rd	104	137.40	125.33	8.78	0.07	9820	0	0
195	P7	Dunn Ave & Duval Dr	136	182.60	35.28	80.68	0.39	2046	0	0
196	P7	Dunn Ave & Lorence Ave	564	714.00	17.20	97.59	0.77	1485	0	0

Appendix B Continued

Table 30 Continued

Sr. no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
197	P7	Dunn Ave & Lucas St	469	582.40	32.27	94.46	1.18	2471	0	0
198	P7	Dunn Ave & Dobson Dr	23	32.20	0.00	100.00	0.10	0	0	0
199	P7	3737 Dunn Ave	25	35.00	0.00	100.00	0.08	0	0	0
200	P7	Dunn Ave & N Wingate Rd	176	244.80	585.66	139.24	0.22	5722	5722	1
201	P7	Dunn Ave & N. Campus Blvd	176	244.80	585.66	139.24	4.93	5722	5722	1
202	P7	N. Campus Blvd & Key Adams Dr	176	244.80	585.66	139.24	0.06	5722	5722	1
203	P7	N. Campus Blvd. & Penny Camp Rd.	6	8.40	0.00	100.00	0.00	0	0	0
204	P7	N.Campus Blvd. & Capper Rd.	0	0.00	0.00	0.00	0.16	0	0	0
205	P7	F.C.C.J. Northside Campus	54	74.60	0.00	100.00	0.00	0	0	0
206	R5	F.C.C.J. Kent Campus	271	377.20	0.00	100.00	36.85	0	0	0
207	R5	Park St. & Glendale St.	236	327.80	0.00	100.00	1.94	0	0	0
208	R5	Park St. & Pinegrove Ave.	20	27.20	0.00	100.00	2.68	0	0	0
209	R5	Park St. & Van Wert Ave.	92	117.40	269.74	129.76	0.23	6275	6275	1
210	R5	Park St. & Ingleside Ave.	104	130.00	269.74	107.49	4.87	6275	6275	1
211	R5	Park St. & Talbot Ave.	138	170.80	569.79	233.60	0.04	39466	6275	1
212	R5	Park St. & Edgewood Ave.	119	144.60	300.04	107.50	0.14	33191	0	0
213	R5	Park St. & Valencia Rd.	58	69.60	300.04	331.09	0.00	33191	0	0
214	R5	Park St. & Seminole Rd.	55	76.80	226.20	194.53	0.88	16968	0	0
215	R5	Park St. & Aberdeen St.	28	38.60	0.00	100.00	0.00	0	0	0
216	R5	Park St. & McDuff Ave.	85	119.00	226.20	90.08	3.48	16968	0	0
217	R5	Park St. & Willow Branch Ave.	101	137.20	245.49	78.93	3.20	19081	0	0
218	R5	Park St. & Cherry St.	199	266.80	231.80	13.12	8.01	5395	1832	1
219	R5	Park St. & James St.	432	544.20	623.91	14.65	3.08	25798	7573	1
220	R5	Park St. & King St.	636	822.60	897.00	9.04	7.82	38446	7573	1
221	R5	King St. & Oak St.	5,253	7,271.80	1,103.52	84.82	3.35	61940	7573	1
222	R5	Riverside Ave. & Barrs St.	5,358	7,442.40	2,438.84	67.23	16.90	172630	8521	1
223	R5	Riverside Ave. & Stockton St.	5,340	7,440.80	2,570.51	65.45	1.85	187041	2780	1
224	R5	Riverside Ave. & Osceola St.	5,379	7,493.60	3,094.89	58.70	0.89	223440	2780	1
225	R5	Riverside Ave. & Copeland St.	1,062	1,432.60	2,222.92	55.17	0.78	146483	2780	1
226	R5	Riverside Ave. & Goodwin St.	1,255	1,664.00	2,183.57	31.22	6.00	240851	0	0
227	R5	Riverside Ave. & Margaret St.	1,512	1,988.40	3,303.70	66.15	5.55	241595	0	0
228	R5	Riverside Ave. & Lomax St.	1,379	1,798.20	4,029.29	124.07	0.95	219050	23136	1
229	R5	Riverside Ave. & Post St.	1,682	2,224.80	6,966.01	213.11	1.43	182124	23136	1
230	R5	Riverside Ave. & Riverside Park Pl	5,631	7,794.40	7,023.25	9.89	1.64	177938	23136	1
231	R5	Riverside Ave. & Roselle St.	5,538	7,667.20	5,421.03	29.30	0.81	145750	9739	1
232	R5	Riverside Ave. & Edison Ave.	5,526	7,685.00	1,649.66	78.53	3.78	98874	0	0

Appendix B Continued

Table 30 Continued

Sr. no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
233	R5	Riverside Ave. & Jackson St.	3,137	4,369.80	276.46	93.67	0.28	26941	0	0
234	R5	Riverside Ave. & Stonewall St.	2,940	4,101.60	264.42	93.55	1.18	21076	0	0
235	R5	Pearl St. & Bay St.	12,060	16,579.00	8,032.69	51.55	2.58	251492	0	0
236	R5	Forsyth St. & Julia St.	23,225	32,174.00	16,677.95	48.16	1.19	577605	4874	1
237	R5	Forsyth St. & Laura St.	23,559	32,324.00	40,412.44	25.02	3.20	1524033	11685	1
238	R5	Forsyth St. & Ocean St.	22,952	31,465.40	30,302.23	3.70	0.68	1211406	11735	1
239	R5	Newnan St. & Adams St.	8,380	11,291.80	22,189.02	96.51	4.63	913534	11735	1
240	R5	Newnan St. & Duval St.	7,978	10,756.40	29,130.87	170.82	0.78	1207881	73981	1
241	R5	Newnan St. & Ashley St.	5,878	7,836.80	29,862.56	281.06	2.10	1096236	69057	1
242	R5	Newnan St. & Beaver St.	5,664	7,536.00	29,339.23	289.32	2.02	1069521	62246	1
243	R5	F.C.C.J. Station	14,486	20,229.00	30,397.42	50.27	143.15	1296758	52995	1
244	R5	Regency Square Hub	3,227	3,930.20	0.00	100.00	42.58	0	0	0
245	R5	9451 S Regency Square Blvd.	384	531.20	6,902.06	1,199.33	1.19	300806	186792	1
246	R5	9550 S. Regency Square Blvd.	1,874	2,483.60	2,623.56	5.64	1.06	114014	0	0
247	R5	S. Regency Square Blvd. & Monument Rd.	1,812	2,410.20	11.28	99.53	2.06	1248	0	0
248	R5	355 Monument Rd.	1,609	2,100.20	1,963.94	6.49	4.34	13413	10355	1
249	R5	445 Monument Rd.	855	1,033.40	1,963.94	90.05	2.60	13413	10355	1
250	R5	514 Monument Rd.	895	1,078.40	1,965.67	82.28	2.60	13605	10355	1
251	R5	544 Monument Rd.	42	54.60	1,965.67	3,500.13	0.68	13605	10355	1
252	R5	989 Monument Rd.	281	349.40	0.00	100.00	0.57	0	0	0
253	R5	Monument Rd. & Treddick Pkwy.	104	131.00	0.00	100.00	3.20	0	0	0
254	R5	Monument Rd. & Lee Rd.	207	272.60	12.37	95.46	1.05	1368	0	0
255	R5	1431 Monument Rd.	118	149.60	12.37	91.73	1.56	1368	0	0
256	R5	1505 Monument Rd.	280	349.80	100.02	71.41	1.83	8635	0	0
257	R5	St. Johns Bluff Rd. & Monument Rd.	288	362.40	100.02	72.40	2.32	8635	0	0
258	R5	St. Johns Bluff Rd. & Causey Ln.	354	452.80	0.00	100.00	0.04	0	0	0
259	R5	St. Johns Bluff Rd. & S. Akers Dr.	146	197.60	285.73	44.60	0.13	112867	0	0
260	R5	St. John's Bluff Rd. & Lone Star Rd.	260	352.40	285.73	18.92	0.63	112867	0	0
261	R5	850 St. Johns Bluff Rd.	296	398.40	392.69	1.43	0.14	8388	4897	1
262	R5	St. Johns Bluff Rd. & Craig Industrial Dr.	96	129.60	210.51	62.43	0.04	4897	4897	1
263	R5	St. Johns Bluff Rd. & Airport Terrace Dr.	48	66.80	0.00	100.00	0.00	0	0	0
264	R5	St. Johns Bluff Rd. & Atlantic Blvd.	812	1,069.40	0.00	100.00	0.60	0	0	0
265	R5	St. Johns Bluff Rd. & Theresa Dr.	865	1,134.00	137.38	87.89	3.82	25087	0	0
266	R5	St. Johns Bluff Rd. & Bradley Rd.	122	149.20	267.93	79.58	0.12	15428	0	0
267	R5	St. Johns Bluff Rd. & Lost Pine Dr.	299	405.20	156.79	61.31	1.29	10600	0	0
268	R5	St. Johns Bluff Rd. & Fraser Rd.	350	471.40	0.00	100.00	0.58	0	0	0

Appendix B Continued

Table 30 Continued

Sr. no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
269	R5	St. Johns Bluff Rd. & Alden Rd.	210	276.80	0.00	100.00	0.81	0	0	0
270	R5	2656 St. Johns Bluff Rd.	244	335.80	27.63	91.77	3.15	7754	0	0
271	R5	St. Johns Bluff Rd. & Judicial Dr.	415	567.80	75.16	86.76	0.00	21090	0	0
272	R5	St. Johns Bluff Rd. & Saints Rd.	525	712.40	132.47	81.41	0.33	37169	0	0
273	R5	St. Johns Bluff Rd. & Beach Blvd.	1,251	1,583.20	2,966.13	87.35	4.09	109166	1380	1
274	R5	Central Pkwy.& St. Johns Bluff Rd.	680	901.60	863.11	4.27	6.77	37682	0	0
275	R5	11655 Central Pkwy.	1,705	2,316.20	469.64	79.72	0.00	102634	0	0
276	R5	11710 Central Pkwy.	2,185	2,904.00	977.60	66.34	0.00	245164	0	0
277	R5	11818 Central Pkwy.	2,545	3,413.60	507.96	85.12	0.03	142530	0	0
278	R5	F.C.C.J. Southside Campus	3	4.20	57.71	1,274.05	8.23	6809	0	0
279	R5	Central Pkwy. & Beach Blvd.	899	1,208.20	0.00	100.00	0.38	0	0	0
280	R5	Beach Blvd. & Central Pkwy.	914	1,239.60	0.00	100.00	0.07	0	0	0
281	R5	12000 Beach Blvd.	520	713.00	1,100.97	54.41	1.50	13806	13686	1
282	R5	Beach Blvd. & Sans Pareil St.	347	449.00	0.00	100.00	0.43	0	0	0
283	R5	3694 Kernan Blvd.	49	64.00	0.00	100.00	7.12	0	0	0
284	R5	Kernan Blvd. & Gehrig Dr.	10	14.00	0.00	100.00	0.04	0	0	0
285	R5	Kernan Blvd. & Mantle Dr.	4	4.20	0.00	100.00	0.45	0	0	0
286	R5	Kernan Blvd. & Hunter's Haven Ln.	6	7.00	0.00	100.00	0.11	0	0	0
287	R5	Kernan Blvd. & Blue Stream Dr.	12	15.40	68.50	344.81	0.09	7504	0	0
288	R5	Kernan Blvd. & First Coast Technology Pkwy.	44	57.40	68.50	19.34	0.14	7504	0	0
289	R5	UNF Dr. & Alumni Dr.	55	77.00	0.00	100.00	0.61	0	0	0
290	R5	U.N.F. Osprey Landing (U.N.F Dr.)	55	77.00	0.00	100.00	0.03	0	0	0
291	R5	U.N.F. Library (U.N.F. Dr.)	0	0.00	0.00	0.00	0.48	0	0	0
292	R5	U.N.F. Arena (U.N.F. Dr.)	0	0.00	0.00	0.00	1.28	0	0	0
293	R5	Town Center & Brightman Bl	90	109.60	0.00	100.00	0.05	0	0	0
294	R5	Town Crossing & Buckhead Branch	773	943.60	0.00	100.00	0.05	0	0	0
295	R5	Town Center Mall	1,735	2,109.00	0.00	100.00	0.20	0	0	0
296	U2	Regency Square Hub	2,934	3,568.00	0.00	100.00	89.82	0	0	0
297	U2	Arlington Expwy & Mill Creek Rd.	316	416.80	680.26	63.21	1.02	53020	0	0
298	U2	Arlington Expwy & Arlingtonwood Ave.	218	280.40	328.23	17.06	0.76	25137	0	0
299	U2	8109 Arlington Expwy.	529	723.60	51.45	92.89	0.00	3940	0	0
300	U2	Arlington Expwy & Townsend Blvd.	727	997.60	221.90	77.76	5.63	2168	2168	1
301	U2	7783 Arlington Expwy.	1,423	1,876.80	245.95	86.90	0.95	4350	2168	1
302	U2	Arlington Expwy & Alderman Rd.	1,040	1,351.40	136.80	89.88	0.44	14532	0	0
303	U2	7579 Arlington Expwy.	760	963.60	136.80	85.80	2.66	14532	0	0
304	U2	Arlington Expwy & Bert Rd.	239	307.60	1,242.53	303.94	2.98	22218	0	0

Appendix B Continued

Table 30 Continued

Sr. no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
305	U2	Arlington Expwy & Arlington Rd.	399	524.80	1,126.46	114.65	7.20	9273	0	0
306	U2	6829 Arlington Expwy.	654	868.00	1,126.46	29.78	3.73	9273	0	0
307	U2	Arlington Expwy & Rogero Rd.	716	954.80	1,126.46	17.98	0.52	9273	0	0
308	U2	Arlington Expwy & Underhill Dr.	653	882.80	107.75	87.79	2.34	18444	0	0
309	U2	Arlington Expwy & Cesery Blvd.	1,455	2,000.80	661.95	66.92	12.88	46517	2045	1
310	U2	Cesery Blvd. & Egret Point Ln.	1,239	1,710.80	521.59	69.51	3.16	20333	2045	1
311	U2	University Blvd & Saxony Woods Ln.	41	50.40	0.00	100.00	0.46	0	0	0
312	U2	University Blvd. & Allen Pl.	205	265.80	647.24	143.51	0.16	18185	0	0
313	U2	University Blvd. & Atlantic Blvd.	728	945.40	947.71	0.24	22.00	36626	0	0
314	U2	University Blvd. & St. Cecilia Rd.	266	357.00	461.22	29.19	0.78	31337	0	0
315	U2	University Blvd. & Kellow Rd.	117	163.80	176.09	7.50	0.35	15458	0	0
316	U2	University Blvd. & Bartam Rd.	242	338.60	0.00	100.00	2.11	0	0	0
317	U2	University Blvd. & Coronet Ln.	1,438	1,893.20	3,368.82	77.94	4.93	41313	24135	1
318	U2	University Blvd. & Cruz Rd.	2,154	2,892.00	3,927.85	35.82	13.71	81020	63840	1
319	U2	University Blvd. & Booth Rd.	2,462	3,431.80	2,407.62	29.84	6.44	198637	39705	1
320	U2	University Blvd. & Harvin Rd.	2,522	3,516.40	3,844.79	9.34	4.46	230093	39705	1
321	U2	University Blvd. & Kennerly Rd.	1,807	2,515.20	3,270.14	30.02	3.03	197755	0	0
322	U2	4140 University Blvd.	1,782	2,468.20	4,021.52	62.93	1.25	186811	2374	1
323	U2	University Blvd. & Bennett Rd.	793	1,065.40	3,000.60	181.64	2.41	95908	2374	1
324	U2	University Blvd. & Barnhill Dr.	861	1,150.40	4,183.23	263.63	4.09	96531	39512	1
325	U2	University Blvd. & Beney Rd.	902	1,161.00	2,979.25	156.61	2.44	84356	39512	1
326	U2	University Blvd & Mt. Carmel Terr	805	1,018.80	3,557.16	249.15	7.72	67332	37138	1
327	U2	University Blvd. & Barnes Rd.	672	856.60	4,485.47	423.64	6.74	60180	3183	1
328	U2	University Blvd. & Spring Park Rd.	701	932.20	3,055.32	227.75	3.06	52650	8265	1
329	U2	University Blvd. & Cagle Rd.	1,045	1,367.80	1,253.63	8.35	1.83	121892	3430	1
330	U2	University Blvd. & Richard St.	1,060	1,387.60	1,234.22	11.05	17.94	119555	3430	1
331	U2	University Blvd. & Philips Hwy.	1,138	1,464.00	805.01	45.01	2.06	59984	0	0
332	U2	University Blvd. & Powers Ave.	2,260	2,991.40	2,920.99	2.35	0.46	22623	2700	1
333	U2	University Blvd. & Chester Ave.	1,957	2,544.80	3,188.70	25.30	2.91	29679	6482	1
334	U2	6005 University Blvd.	2,112	2,757.00	3,030.23	9.91	6.11	39439	3782	1
335	U2	University Blvd. & St. Augustine Rd.	1,667	2,223.20	1,420.11	36.12	1.67	68117	16238	1
336	U2	University Blvd. & Minuteman Ln.	1,203	1,618.40	1,304.58	19.39	2.39	74113	12456	1
337	U2	University Blvd. & Graywood Rd.	520	705.00	866.79	22.95	1.24	49934	7026	1
338	U2	University Blvd. & Colgate Rd.	225	307.80	589.11	91.39	0.72	40276	0	0
339	U2	University Blvd. & Auburn Rd.	605	788.60	3,338.13	323.30	3.19	128462	67039	1
340	U2	San Jose Blvd. & Cornell Rd.	449	564.60	3,973.26	603.73	0.95	154487	67039	1

Appendix B Continued

Table 30 Continued

Sr. no.	Route Name	Stop Name	Total Employment	Trips Generated by Employment	Trips Generated using Parcel land use based Trip Rates	Absolute Percent Difference	Total Weekday Boarding	Area of the Non-Residential land use	Area of Special Generator	Special Generator Dummy
341	U2	San Jose Blvd. & Flanders Rd.	115	144.40	933.32	546.34	0.21	45421	0	0
342	U2	San Jose Blvd. & Arcadia Dr.	97	123.80	822.02	563.99	1.95	40562	0	0
343	U2	San Jose Blvd. & San Amaro Dr.	60	78.40	119.61	52.56	0.43	5222	0	0
344	U2	San Jose Blvd. & E. Worth Dr.	210	271.40	200.58	26.09	0.80	5135	4493	1
345	U2	San Jose Blvd. & Gadsden Rd.	12	12.60	0.00	100.00	0.02	0	0	0
346	U2	San Jose Blvd. & Monterey St.	7	5.00	0.00	100.00	1.48	0	0	0
347	U2	San Jose Blvd. & Miramar Ave.	7	5.00	0.00	100.00	0.75	0	0	0
348	U2	San Jose Blvd. & Eutaw Pl.	11	10.60	0.00	100.00	0.05	0	0	0
349	U2	San Jose Blvd. & Morvenwood Rd.	13	13.60	0.00	100.00	0.11	0	0	0
350	U2	San Jose Blvd. & Mapleton Rd.	13	17.80	29.22	64.16	0.02	3201	0	0
351	U2	San Jose Blvd. & S Waterman Rd.	10	13.60	29.22	114.85	0.14	3201	0	0
352	U2	San Jose Blvd. & Saratoga Dr.	255	356.20	0.00	100.00	0.08	0	0	0
353	U2	San Jose Blvd. & Inwood Terrace	393	537.60	261.60	51.34	0.32	17916	0	0
354	U2	San Jose Bl & Oriental Gardens Rd	155	205.20	261.60	27.49	0.23	17916	0	0
355	U2	Hendricks Ave. & Lorimier Rd.	12	8.40	0.00	100.00	0.13	0	0	0
356	U2	Hendricks Ave. & Pineridge Rd.	15	12.20	0.00	100.00	0.03	0	0	0
357	U2	Hendricks Ave. & Marco Pl.	39	49.80	0.00	100.00	0.00	0	0	0
358	U2	San Marco Blvd. & Alford Pl.	1,010	1,297.00	6,732.15	419.06	0.01	119764	59975	1
359	U2	San Marco Blvd.& Balis Pl.	1,021	1,311.00	6,732.15	413.51	0.53	119764	59975	1
360	U2	San Marco Blvd. & Naldo Ave.	911	1,168.40	6,289.45	438.30	0.33	96930	58531	1
361	U2	San Marco Blvd. & Largo Rd.	553	709.80	6,509.19	817.05	0.09	97152	58531	1
362	U2	San Marco Blvd. & Landon Ave.	412	530.20	1,876.14	253.86	0.07	61526	19613	1
363	U2	San Marco Blvd. & LaSalle St.	477	615.00	1,500.29	143.95	0.48	59694	2224	1
364	U2	San Marco Blvd. & Phillips St.	878	1,159.80	1,034.45	10.81	0.72	61319	2224	1
365	U2	San Marco Blvd. & Nira St.	801	1,056.20	956.12	9.48	1.15	54977	2224	1
366	U2	Nira St. & Larue Ave.	833	1,104.60	922.39	16.50	0.47	52364	2224	1
367	U2	Nira St. & Flagler Ave.	953	1,286.60	1,257.68	2.25	0.03	47168	4885	1
368	U2	Nira St. & Hendricks Ave.	826	1,114.40	1,586.96	42.40	0.17	66399	4885	1
369	U2	Kings Ave. Station	3,884	5,346.20	5,944.75	11.20	0.10	177884	0	0