Evaluating the Impact of Transit-Oriented Development

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16. Abstract

Transit-oriented development (TOD) is an increasingly popular urban form. Based on a survey of residents of TOD projects in areas served by Dallas Area Rapid Transit, Fort Worth T, and Capital Metro (Austin) rail transit, moving into TOD decreases VMT by an average of 15 percent, or about 3,500 miles per year, which impacts TxDOT motor fuel tax revenues. The data also indicate that these households shift their choice of route to include more arterial roads versus highways. Differential behavior is observed among the three areas studied with the greatest impact being on the DART system and the Capital Metro system showing smaller changes in TOD resident travel behaviors. Residents of TOD choose their housing based mostly on commuting distance and lifestyle characteristics, such as proximity to dining and entertainment venues. Proximity to a transit rail station is at least moderately important for 57 percent of respondents. The report recommends that TxDOT look to incorporate TOD into facility planning and design and seek ways to extract value from TOD projects.

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LIST OF ABBREVIATIONS AND SYMBOLS

ARB	Air Resources Board (California)
BART	Bay Area Rapid Transit
BRT	Bus rapid transit
Caltrans	California Department of Transportation
CAFE	Corporate Average Fuel Efficiency
CAMPO	Capital Area Metropolitan Planning Organization
CBTP	Community-Based Transportation Planning
COG	Council of Government
CTOD	Center for Transit-Oriented Development
CTR	Commute Trip Reduction
DART	Dallas Area Rapid Transit
DCA	Department of Community Affairs
DDOT	District of Columbia Department of Transportation
DOT	Department of Transportation
EPA	Environmental Protection Agency
FDOT	Florida Department of Transportation
FTA	Federal Transit Administration
GMA	Growth Management Act
GTEC	Growth and Transportation Efficiency Center
HUD	Department of Housing and Urban Development
ITC	Intermodal Transportation Center
JRTC	Jacksonville (Florida) Regional Transportation Center
MDOT	Maryland Department of Transportation
MEDCo	Maryland Economic Development Corporation
Metro	Los Angeles County Metropolitan Transportation Authority
Metro	Portland (OR) area regional government
METRO	Metropolitan Transit Authority of Harris County (TX)
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MRSC	Municipal Research and Services Center of Washington
NHTSA	National Highway Traffic Safety Administration
NJDOT	New Jersey Department of Transportation
OAR	Oregon Administrative Rule

ODOT	Oregon Department of Transportation
PCTI	Pennsylvania Community Transportation Initiative
PDC	Portland Development Commission
PMT	Person miles traveled
PPPs	Public/private partnerships
PSC	Partnership for Sustainable Communities
PennDOT	Pennsylvania Department of Transportation
RTP	Regional Transportation Plan
SRC	Survey Research Center
TAZs	Traffic analysis zones
TGM	Transportation and growth management grants
TIF	Tax increment district
TIGER II	Transportation Investment Generating Economic Recovery
TOD	Transit-oriented development
TP3	Transportation Public-Private Partnership Program (Maryland)
TRE	Trinity Railway Express
TTS	Transportation Tomorrow Survey
TxDOT	Texas Department of Transportation
UGA	Urban growth area
UT	University of Texas at Austin
VMT	Vehicle miles traveled
Vtrans	Vermont Agency of Transportation
WSDOT	Washington State Department of Transportation

I. INTRODUCTION

Transit-oriented development (TOD) is increasingly seen by local planning agencies, cities, and counties as an opportunity to counteract some of the deleterious effects of sprawling development patterns in Texas's urbanized areas. In doing so, many occupants of TODs, both residents and businesses, also believe these environments lead to a higher quality of life and provide better opportunities for commerce. Previous research in other areas of the United States suggests that TOD not only alters transportation mode choice, trip length (and ultimately vehicle-miles traveled), and travel frequency, but it can also affect route selection. If these impacts also apply to Texas, the Texas Department of Transportation (TxDOT) needs a better understanding of the nature and magnitude of these impacts on travel behavior. Moreover, if TOD can help TxDOT achieve its goals of improving mobility and promoting statewide economic development, then understanding how a state transportation agency can encourage TOD becomes an important consideration. This report presents the findings of a research study that explores TOD's effects on travel behavior among Texas residents of TODs. Specifically, it concentrates on the nature and extent of TODs impacts on mode choice, travel demand, and TxDOT's revenues from gasoline consumption taxes. This report also explores the possible roles that TxDOT could undertake to encourage future transit-oriented development projects, which could enhance overall transportation network efficiency.

While Texas is famously known for its preference for, and its dependence upon, automobiles for almost all personal transportation, several of its major cities have embraced rail transit (either commuter rail or light rail), as an opportunity to encourage alternate transportation modes, reduce congestion on local roadway networks, and to improve accessibility. Transit-oriented development, which seeks to integrate high density residential and commercial land uses near transit stations, is a natural complement to the development of rail transit because it increases ridership while also creating environments where residents can reduce their number of automobile trips. There are more than 100 TOD projects in the United States (Lund 2006). Currently, four cities in Texas have access to commuter rail or light rail service: Dallas, Houston, Fort Worth, and Austin. Section II of this report provides an inventory of existing and ongoing TOD projects in Texas.

Section III offers a comprehensive review of the rich body of literature regarding TOD in both professional and academic publications. The focus of this review is on travel behavior and transportation agency involvement in the promotion of TOD.

Within Texas, the Dallas-Fort Worth region has the most extensive rail transit network with the Trinity Rail Express (TRE) commuter line (linking downtown Fort Worth with downtown Dallas) and Dallas Area Rapid Transit's (DART) light rail system, which serves 35 stations along two lines (Red and Blue). Given the extent and variety of development that has occurred near DART light rail stations, the DART system is chosen as the base for a series of focus groups involving TOD residents. These focus groups helped form our understanding of the issues related to transportation mode choice and its relationship with choosing to live in a TOD. The findings of these focus group sessions are reported in Section IV.

Section V details the findings of a survey of TOD residents on the TRE, DART, and Capital Metro rail transit systems. The results of these surveys are compared to the findings from a control group survey to identify differential transportation behaviors between TOD and non-TOD residents. In broad terms, our examination looks at how moving into TOD is associated with changes in travel to work, non-work related local travel, and the lifestyle choices that drive demand for TOD residential properties.

Based on the responses to our travel behavior surveys, we quantify the impacts associated with moving into TOD residential units on routing choices and the number of annual miles traveled. These data also provide us with the information needed to assess any impacts on TxDOT's revenues tied to motor fuel taxes. Given the increasing number of rail transit options available to Texas residents and the increasing popularity of TOD living, we offer projections of the impacts on highway miles traveled and motor fuel tax revenues associated with future development of TOD properties. Section VI reports these current and projected impacts on miles traveled and motor fuels tax revenue.

Section VII reviews the role of state transportation agencies in promoting the development of TOD properties. Taking a case study approach, the narrative examines how agencies in nine states, plus the District of Columbia, have worked with rail transit systems and developers to promote new TOD construction.

Finally, Section VIII offers a series of recommendations for integrating TOD into TxDOT's statewide transportation planning process. These recommendations include identifying ways to institutionalize coordination among state agencies, transit systems, and the private sector. This section also considers economic issues such as sources of funding for state transportation agency participation in TOD and finding ways to capture value by state agencies and to enhance sustainable development.

II. INVENTORY OF TRANSIT-ORIENTED DEVELOPMENT IN TEXAS

Transit-oriented development that typically combines high-density residential with commercial land uses has accompanied the growth of transit rail systems. These mixed-use developments are purported to increase rail ridership while reducing automobile trips, air pollution, and congestion. The following presents an overview of existing and known planned TOD in Dallas, Fort Worth, Austin, and Houston.

Dallas

Existing TOD

The Dallas Area Rapid Transit began offering commuter rail service in Dallas in the 1990s. Numerous stations along DART rail lines involve mixed-use TODs. For example, DART's Mockingbird Station consists of over 600,000 square feet of development that includes approximately 700 loft-style apartments, 90 retail shops and restaurants, and a movie complex. Table 1 identifies TOD at select DART stations.

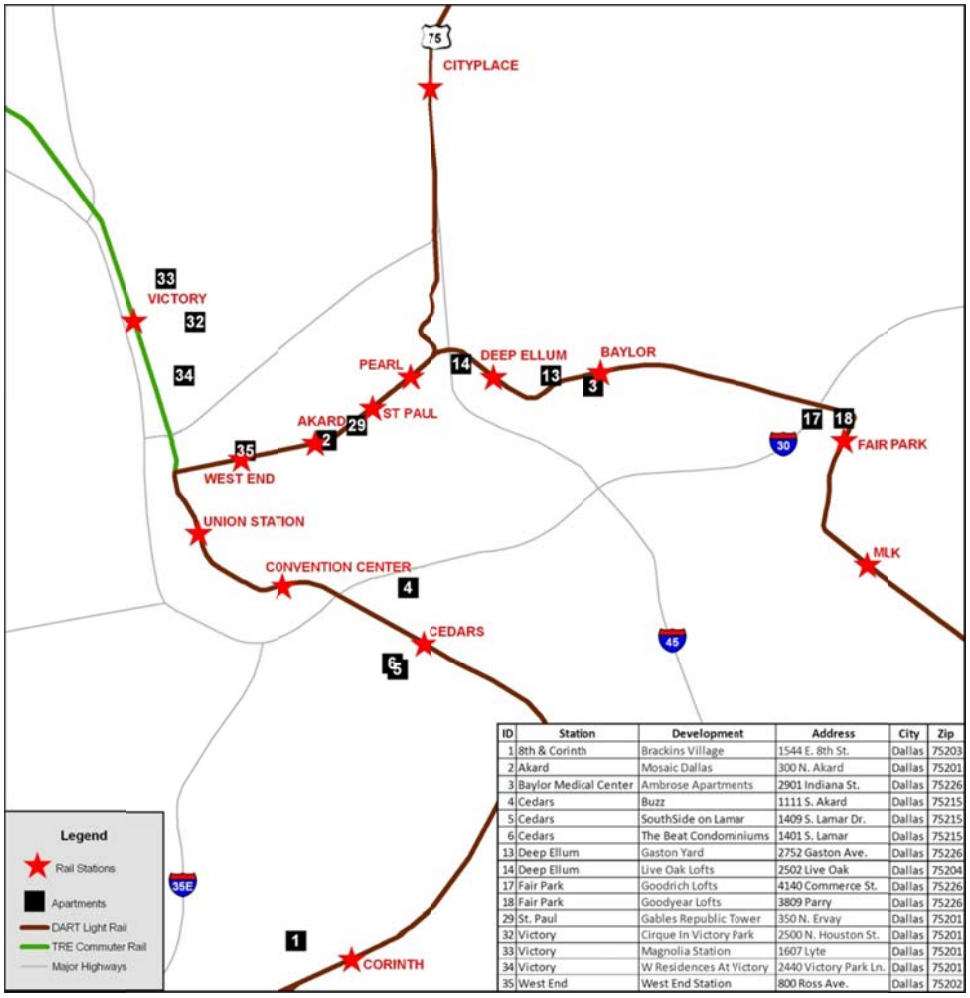
Table 1. TOD at Select DART Stations

Station/Development	Use	Mixed-Use Description
Mockingbird		
Mockingbird Station	Mixed-Use	Retail, Multi-family, Office, Movie Theater
The Lofts at Mockingbird Station	Multi-family	
Residences at Hotel Palomar	Multi-family	
The Phoenix Midtown	Multi-family	
Lovers Lane		
University Crossroads Condos	Condominiums	
Park Lane		
The Heights at Park Lane	Mixed-Use	Retail, Multi-family, Office, Hotel
Galatyn Park		
Galatyn Park	Mixed-Use	Hotel, Eisemann Auditorium, Retail, Office
The Venue	Multi-family	
Downtown Plano		
Eastside Village I and II	Mixed-Use	Multi-family, Retail
Parker Road		
Pleasant Park Apartments	Multi-family	

Table 1. TOD at Select DART Stations		
Station/Development	**Use**	**Mixed-Use Description**
Cedars		
SouthSide on Lamar	Mixed-Use	Multi-family, Office, Small Retail
Buzz	Multi-family	
The Beat Condominiums	Multi-family	
Dallas Police Headquarters	Civic	
Gilley's, Poor David's Pub, Bill's Records	Retail	
West End		
West End Station	Multi-family	
Westmoreland		
Park Creek Manor	Multi-family	
Downtown Garland		
5th Street Crossing	Mixed-Use	Multi-family, Office, Small Retail
Dallas Zoo		
Ewing Villas	Townhomes	
St. Paul		
Gables Republic Tower	Multi-family	
Akard		
Mosaic Dallas	Multi-family	
Victory*		
Magnolia Station	Multi-family	
W Residences At Victory	Condominiums	
Cirque In Victory Park	Multi-family	
8th & Corinth		
Brackins Village	Multi-family	
Deep Ellum		
Gaston Yard	Multi-family	
Live Oak Lofts	Multi-family	
Baylor Medical Center		
Ambrose Apartments	Multi-family	
Fair Park		
Goodyear Lofts	Multi-family	
Goodrich Lofts	Multi-family	
West Irving		
Jackson Square	Multi-family	

*TRE also serves this station.

The Dallas Central Business District is home to several DART stations, including Cedars, Akard, and Victory. Transit-oriented development near these stations is listed in Table 1 and mapped in Figure 1.

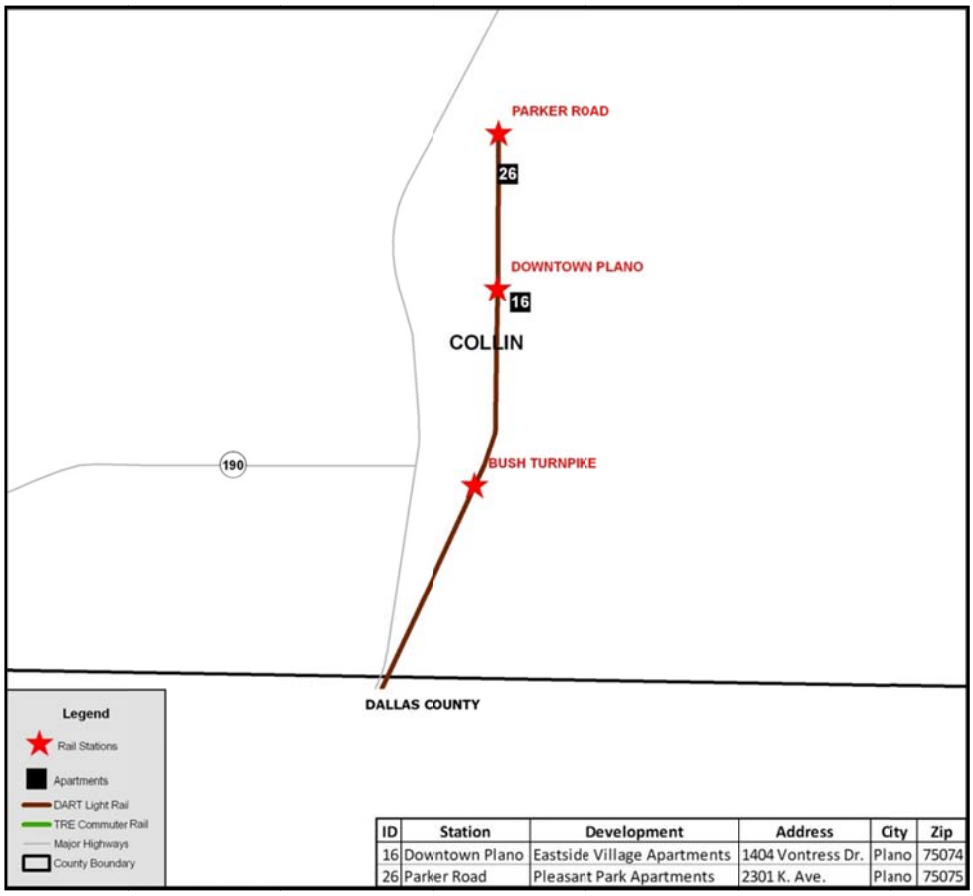


ID	Station	Development	Address	City	Zip
1	8th & Corinth	Brackins Village	1544 E. 8th St.	Dallas	75203
2	Akard	Mosaic Dallas	300 N. Akard	Dallas	75201
3	Baylor Medical Center	Ambrose Apartments	2901 Indiana St.	Dallas	75226
4	Cedars	Buzz	1111 S. Akard	Dallas	75215
5	Cedars	SouthSide on Lamar	1409 S. Lamar Dr.	Dallas	75215
6	Cedars	The Beat Condominiums	1401 S. Lamar	Dallas	75215
13	Deep Ellum	Gaston Yard	2752 Gaston Ave.	Dallas	75226
14	Deep Ellum	Live Oak Lofts	2502 Live Oak	Dallas	75204
17	Fair Park	Goodrich Lofts	4140 Commerce St.	Dallas	75226
18	Fair Park	Goodyear Lofts	3809 Parry	Dallas	75226
29	St. Paul	Gables Republic Tower	350 N. Ervay	Dallas	75201
32	Victory	Cirque In Victory Park	2500 N. Houston St.	Dallas	75201
33	Victory	Magnolia Station	1607 Lyte	Dallas	75201
34	Victory	W Residences At Victory	2440 Victory Park Ln.	Dallas	75201
35	West End	West End Station	800 Ross Ave.	Dallas	75202

Figure 1. TOD near DART Stations in the Dallas Central Business District.

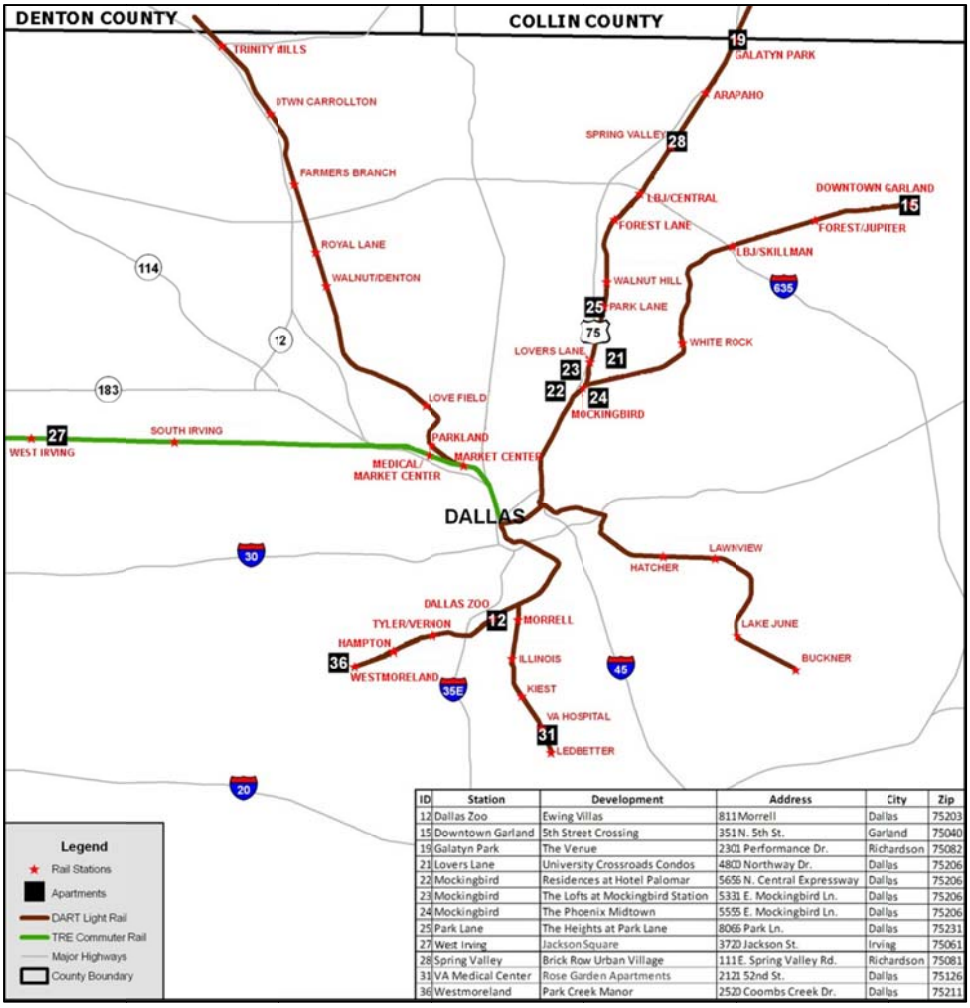
Both the Downtown Plano Station and Garland Station TODs emphasized the revitalization of their historic downtown areas. Downtown Plano contains 500 residential units and 40,000 square feet of retail within Eastside Villages I and II. In addition, another 450 residential units and 40,000 square feet of commercial development are currently under construction. Downtown Garland's ULI award-winning 5th Street Crossing TOD is made up of 189 residential units with an additional 13,500 square feet of retail below (See Figure 2). Along Richardson's Telecom Corridor, the Galatyn Park TOD boasts a 336 room Renaissance Hotel, the Eisemann Center for Performing Arts, and the Venue multi-family

residential complex. See Figures 3 and 4 for TOD near DART stations in Collin and Dallas Counties.



ID	Station	Development	Address	City	Zip
16	Downtown Plano	Eastside Village Apartments	1404 Vontress Dr.	Plano	75074
26	Parker Road	Pleasant Park Apartments	2301 K. Ave.	Plano	75075

Figure 3. TOD near Collin County DART Stations.



ID	Station	Development	Address	City	Zip
12	Dallas Zoo	Ewing Villas	811 Morrell	Dallas	75203
15	Downtown Garland	5th Street Crossing	351 N. 5th St.	Garland	75040
19	Galatyn Park	The Verue	2301 Performance Dr.	Richardson	75082
21	Lovers Lane	University Crossroads Condos	4800 Northway Dr.	Dallas	75206
22	Mockingbird	Residences at Hotel Palomar	5626 N. Central Expressway	Dallas	75206
23	Mockingbird	The Lofts at Mockingbird Station	5331 E. Mockingbird Ln.	Dallas	75206
24	Mockingbird	The Phoenix Midtown	5555 E. Mockingbird Ln.	Dallas	75206
25	Park Lane	The Heights at Park Lane	8066 Park Ln.	Dallas	75231
27	West Irving	JacksonSquare	3720 Jackson St.	Irving	75061
28	Spring Valley	Brick Row Urban Village	111 E. Spring Valley Rd.	Richardson	75081
31	VA Medical Center	Rose Garden Apartments	2121 52nd St.	Dallas	75126
36	Westmoreland	Park Creek Manor	2520 Coombs Creek Dr.	Dallas	75211

Figure 4. TOD near Dallas County DART and TRE Stations.

Anticipated TOD

Located along DART's Red Line, the Park Lane Station TOD is under construction (see Figure 5). When completed, the 33.5 acre development will have over 600 high-rise residential units, 700,000 square feet of retail, 816,000 square feet of Class A office space, and a 250 room luxury hotel. And, infrastructure construction has begun on the future development of the 70 acre, 2 million square foot mixed-use Lake Highlands Town Center TOD located along the future DART Blue Line expansion.

The DART Orange Line, which will run from near the Parkland Station to DFW International Airport and is scheduled to open in 2011, has been attracting significant development interest for TOD projects. The City of Irving has designated the Las Colinas Urban Center as its foray into TOD development. Some of the projects in this district are already built in anticipation of transit rail service that connects Irving with the airport and Dallas. Other projects are under construction or in planning phases, which includes those projects that have been delayed by current economic and financial market conditions. Based on the projects that are completed, underway, or firmly planned, the Las Colinas Urban Center will have 840,000 square feet of retail space, 1.3 million square feet of office space, 7,600 multi-family residential units, 283 single family dwellings, and two hotels. In addition, city voters have approved bonds to fund a civic complex that includes a 250,000 square foot convention center and 3,400-seat entertainment venue.

In addition to the previously listed DART developments, the following projects are at either the conceptual or planning development phases:

- Carrollton: Conceptual phase.
  - Residential development on 300 acres ranging from 15 units per acre to 115 units per acre density.
  - Mixed-use 500,000 square foot development include retail, hotel, and residential.
- Farmers Branch Town Center: Planning phase.
  - High density residential/retail mixed-use development project on 7.4 acres.

As a part of DART TOD, we include the following projects to be located along the new Denton County Transportation Authority A-Train line. This line will connect with DART Rail at the Trinity Mills Station in Carrollton.

- Downtown Denton: Early planning phase.
  - Most recent plans include the eventual development of 1,213 to 1,993 residential units, 13.4 to 23.7 acres of retail, 2.5 to 9.3 acres of light industrial land uses, 1.7 to 9.3 acres for institutional uses, 18 acres of civic space, and 52 acres or park/open spaces.

- Hebron Station: Planning phase.
  - Proposed project includes 20 acres of commercial development including 20,000 square feet of retail space, 1,755 residential units in a 52-acres mixed-use development, and 149 acres of parks.
- Lake Lewisville: Conceptual phase.
  - The most recently announced vision for the Lake Lewisville transit district development includes over 400,000 square feet of retail space, 83,000 square feet of restaurants, a 200-room hotel, 100,000 square feet of civic space, 56 attached single-family residential units, and 598 multi-family residential units.

Fort Worth

The Trinity Railway Express provides commuter rail service connecting downtown Fort Worth (Texas & Pacific Station on Lancaster Avenue) with downtown Dallas (Union Station on Houston St.). The TRE began offering commuter rail service at Union Station in Dallas in late 1996. Five years later, in December 2001, TRE service extended to the Texas & Pacific Station, thus completing the rail link between downtown Dallas and downtown Fort Worth.

There are 10 stations along the TRE, and a DART rail line also serves Victory and Union Stations in downtown Dallas. Information about TOD at Victory Station can be found in Table 1; TOD at TRE stations in Dallas County is shown in Figure 4 above. Of the remaining TRE stations, Centreport, Intermodal Transportation Center, and Texas & Pacific Stations all boast multi-family TOD near the stations. See Table 2, Figure 6, and Figure 7 for details of TOD at TRE stations in Fort Worth.

Table 2. TOD at Fort Worth TRE Stations

Station/Development	Use
CentrePort	
Camden Centreport	Multi-family
Centreport Landing	Multi-family
Centre Oaks	Multi-family
Gateways at Centreport	Multi-family
Summers Landing	Multi-family
Intermodal Transportation Center	
Le Bijou	Multi-family
Texas and Pacific	
Texas & Pacific Lofts	Multi-family

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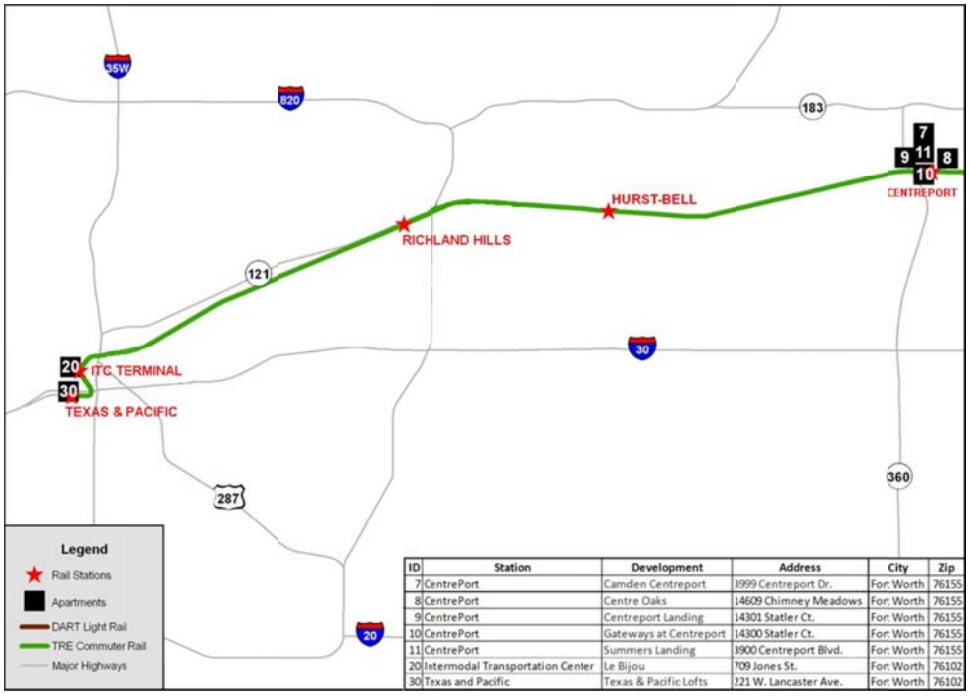


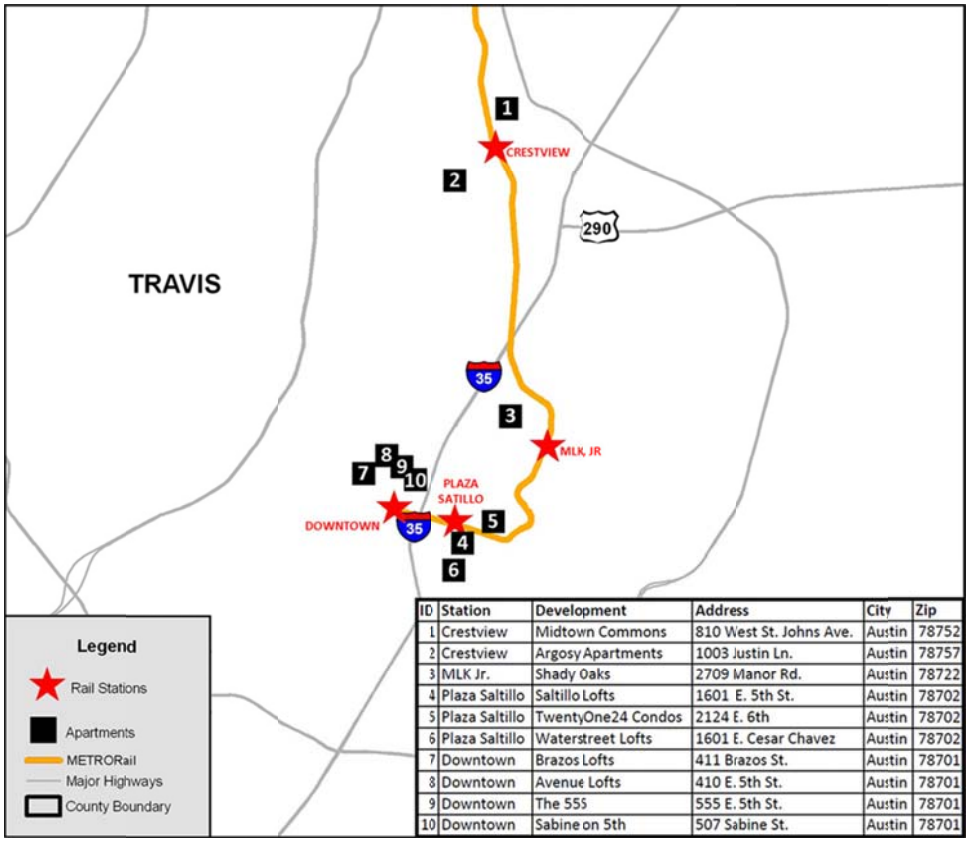
ID	Station	Development	Address	City	Zip
7	CentrePort	Camden Centreport	1999 Centreport Dr.	For. Worth	76155
8	CentrePort	Centre Oaks	14609 Chimney Meadows	For. Worth	76155
9	CentrePort	Centreport Landing	14301 Statler Ct.	For. Worth	76155
10	CentrePort	Gateways at Centreport	14300 Statler Ct.	For. Worth	76155
11	CentrePort	Summers Landing	1900 Centreport Blvd.	For. Worth	76155
20	Intermodal Transportation Center	Le Bijou	709 Jones St.	For. Worth	76102
30	Texas and Pacific	Texas & Pacific Lofts	121 W. Lancaster Ave.	For. Worth	76102

Figure 7. TOD at Tarrant County TRE Stations.

Austin

in.

The City of Austin and surrounding suburbs have enthusiastically embraced TOD as an important urban design choice with explicit planning for TOD districts that goes back several years before the opening of Capital MetroRail service in March of this year. For example, Sabine on 5th Condominiums located near the Downtown Station were completed in 2008 (see Figure 8). TOD located at four Capital MetroRail stations are mapped in Figure 9 and listed in Table 3.



ID	Station	Development	Address	City	Zip
1	Crestview	Midtown Commons	810 West St. Johns Ave.	Austin	78752
2	Crestview	Argosy Apartments	1003 Justin Ln.	Austin	78757
3	MLK Jr.	Shady Oaks	2709 Manor Rd.	Austin	78722
4	Plaza Saltillo	Saltillo Lofts	1601 E. 5th St.	Austin	78702
5	Plaza Saltillo	TwentyOne24 Condos	2124 E. 6th	Austin	78702
6	Plaza Saltillo	Waterstreet Lofts	1601 E. Cesar Chavez	Austin	78702
7	Downtown	Brazos Lofts	411 Brazos St.	Austin	78701
8	Downtown	Avenue Lofts	410 E. 5th St.	Austin	78701
9	Downtown	The 555	555 E. 5th St.	Austin	78701
10	Downtown	Sabine on 5th	507 Sabine St.	Austin	78701

Figure 9. TOD along Capital MetroRail in Austin.

Table 3. TOD at Select Austin Commuter Rail Stations

Station/Development	Use	Mixed-Use Description
Crestview		
Mid-Town Commons	Mixed Use	Retail, Office, Multi-family
Argosy Apartments	Multi-family	
MLK Jr.		
Shady Oaks	Multi-family	
Plaza Saltillo		
Saltillo Lofts	Multi-family	
TwentyOne 24 Condos	Condominiums	
Waterstreet Lofts	Mixed-Use	Multi-family, Office
Downtown		
Brazos Lofts	Multi-family	
Avenue Lofts	Multi-family	
The 555	Condominiums	
Sabine on 5th	Condominiums	

Currently, the Crestview Station has the only TOD along the line under construction (see Figure 10). When completed, it will contain 180,000 square feet of retail and office space,

along with over 1,000 residential homes. TOD is being planned, but is not yet underway, at other stations along Capital MetroRail.

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The City of Leander characterizes their urban planning/renewal effort as TOD. The most recently published plans call for TOD projects that will encompass 1,462 acres at build-out. However, the core TOD for this project is envisioned as high-density mixed-use on 35 acres immediately surrounding the Leander Station.

The Cattellus Development Group is currently in phase one of redeveloping the former Robert Mueller Municipal Airport, which was closed in 1999. Simply known as Mueller, the development is described as a pedestrian friendly and transit-oriented community. The master planned community sits on 711 acres, will support 4,600 single- and multi-family homes, and features more than 140 acres of open space. The development does not have access to rail at this time, but construction of a Mueller Station is in the conceptual phase. There have also been discussions for a proposed street-car based circulator connecting the development to the downtown area; bus service is currently available.

Houston

The Metropolitan Transit Authority of Harris County (METRO) provides bus and rail service to the Houston area. We found only a few examples of rail-oriented TOD in Houston.

Though originally slated for completion in 2009, the Venue Museum District project located near downtown Houston is a 224-unit multi-family residential facility being built on top of a parking garage. This project opened in mid-February 2010 (see Figure 11).

TOD

Still in the planning stage, the suburb of Jersey Village has proposed a 297-acre mixed-use development that will include pedestrian friendly streets and a variety of housing options. A feasibility study (scheduled for completion in February 2011) is underway to review both public and private

funding options to support the project. Finally, Houston METRO also characterizes the Cypress Village Station as a TOD. Since this development is not specifically served by a rail system, it was not included in our analysis.

III. COMPREHENSIVE REVIEW OF THE LITERATURE

The topic of transit-oriented development is a popular one in transportation planning, and this literature review will synthesize the findings of academic studies that address three primary questions often studied by TOD researchers. Namely, does modification of the urban form influence travel demand; does TOD affect travel mode choice and trip generation; and what are the impacts of TOD on miles traveled? These discussions are then followed by an overview of bus TOD, which is a topic that is frequently overlooked by transportation and urban planners. Despite this neglect, bus TOD is becoming more relevant as more transit agencies implement bus rapid transit (BRT) services. The next section summarizes the findings of various research studies that have identified some of the limits to TOD's ability to affect travel demand. The chapter concludes with a brief discussion of the relevance of these findings for TxDOT's interests and needs.

Influencing Travel Demand by Altering the Urban Form

The goal of manipulating travel demand through the urban form is one of the distinguishing characteristics of TOD or neo-traditional development. As a result, the comparison of traditional neighborhoods (i.e., pre World War II) to suburban neighborhoods (i.e., post World War II) is a common theme in the research literature. While there are differences between TOD and traditional or neo-traditional neighborhoods (primarily the level of density) the intrinsic characteristics (e.g., grid-like street design, mixed land use, accessibility to retail and services within walking distance, denser than suburban housing, etc.) are similar and studies of traditional or neo-traditional neighborhoods can serve as a proxy for the patterns that might develop in TOD projects.

Previous research has shown that urban densification is linked to an increased use of alternate travel modes and that housing near commercial development encourages greater pedestrian activity. Among others, Lund (2003) points to studies by Gordon and Peers (1993), Handy (1992, 1996a, 1996b), Steiner (1996), and Shriver (1997) that demonstrate this connection. These studies have also demonstrated that non-work pedestrian activity is higher when there is a large number of amenities nearby, the amenities are a short distance away, and

the pathway to reach them is direct (Lund 2003). Research by Ewing, Haliyur, and Page (1994), on the other hand, found that a sample of Florida's households living in suburban neighborhoods spent as much as 66 percent more time traveling than residents of its traditional cities. Other studies have shown that street layouts can affect residents' willingness to walk or bike for localized trips. Using space syntax theory, a method of quantitatively measuring the relational properties of urban space, Baran, Rodríguez, and Khattak (2008) examined the impact of street layout on residents' willingness to walk. The researchers studied a set of New Urbanist designed neighborhoods in the Chapel Hill-Carroboro, North Carolina, area and a set of typical suburban neighborhoods in the same area for a control group. With 920 travel diaries, they analyzed the residents' walking habits and found that street networks that provide more opportunities for multiple routes and greater access to the overall street network led to a higher number of leisure walking trips. They also found that the higher the overall access to the transportation network, the greater the number of utilitarian walking trips.

Impacts of TOD on Travel Mode Choice and Trip Generation

Much of the existing literature focuses on TOD's influence on two aspects of travel behavior: travel mode choice and trip generation. In the case of trip generation, researchers often parse travel demand between workers and residents or, in transportation modelers' parlance, between work and non-work trips. Transportation planners are especially interested in work commute trips because most of these trips occur during peak travel demand periods and present the greatest opportunities to shift modes and relieve congestion on the roadway network.

The findings of various research studies demonstrate that the availability of rail transit service encourages higher rates of transit usage for work commute trips. Cervero (2006a) summarized the results of a consultant study from the late-1980s (JHK and Associates 1987), which found that 50 percent of workers in Washington, D.C., whose office was within 1,000 feet of a rail station, used transit. However, in the nearby suburban areas of Silver Springs and Crystal City, the percentages ranged from 16 to 19 percent. Research published during the early-1990s by Cervero (1993) found that more than half the residents who moved within

1/2 mile of a Bay Area Rapid Transit (BART) station switched travel modes from automobile to transit for commuting (as summarized by Zhang and Yi 2006). An unpublished study of the San Francisco area by Martin (1996), which was reviewed by Cervero (2006a), found that 19.3 percent of residents who lived and worked near a BART station used transit, compared to 12.8 percent who worked near a station but did not live within a BART-served city. Lund, Cervero, and Willson (2004) surveyed residents and office workers at a sampling of TODs located along California's major urban rail systems. The researchers found that residents living in TODs were five times more likely to use transit than the average worker in the same city. The ridership varied by system but the most mature systems (that also had smart growth development patterns) had the highest ridership. They also found that during 2003, employees working in offices located in TOD projects were 3.5 times more likely to use transit for travel to work than other workers. This was a noticeable uptick from 1993, when TOD office workers were 2.7 times more likely to commute by transit. Frank and Pivo (1994) analyzed data from the Puget Sound region between 1989 and 1994. Their research showed major increases in the number of transit trips by employees at certain employment density thresholds, namely 20 to 75 employees per acre and more than 125 employees per acre. Travel trips in residential areas, however, were less sensitive to densification and needed 13 or more residents per acre before any mode changes were detected.

The proximity of TOD is an important factor that influences the likelihood of residents or workers to use transit or walk. Cervero (2006a) studied transit ridership to office developments within 1/2-mile of suburban rail stations in Los Angeles, Sacramento, San Diego, East Bay (Alameda and Contra Costa Counties), and South Bay (Santa Clara County in the San Francisco area). With a sample of 877 travel surveys from workers in 10 buildings, Cervero found that 18.8 percent of workers used rail or bus transit, which was 3 times the weighted average of the county level. Seven of the buildings in the study were also surveyed by Cervero in 1992, and the rate of transit ridership in that subset had increased from 14.3 percent to 23.9 percent. After transit commuters reached the rail station, 78 percent of workers walked to work and most of the remainder rode a feeder bus. Cervero also found that, as workplaces changed, more than half did not change their commute mode, although 10.8 percent shifted from

automobile to transit and 8.8 percent changed from transit to automobile. The study demonstrated that the availability of free parking was a significant factor encouraging transit riders to drive instead of using transit. Additionally, frequent feeder bus service and employer sponsored transit passes increased transit ridership. Once at work, employees' mid-day trips of less than 1/4-mile from the workplace were made on foot 96 percent of the time, which fell to just under 25 percent when the distance increased from 0.25 to 1.0 miles. For more than a mile, 80 percent of the trips were by automobile, and less than 5 percent by transit. He reported that the study supported an earlier finding (Cervero 1989), which "underscore[d] the importance of creating mixed-use environments in and around office sites. Islands of stand-alone office buildings, regardless of how close they are to transit, are unlikely to draw many workers to trains and busses if there is a risk of being stranded midday, unable to attend to personal affairs" (Cervero 1989, 52).

Past research suggests that residential TODs also have a strong influence on commuter mode choice. Handy, Cao, and Mokhtarian (2006) found that residents of traditional neighborhoods were almost three times more likely to walk to the store than in suburban neighborhoods. Residents of traditional neighborhoods were more likely to say they walked to all destinations than residents of suburban neighborhoods. Additionally, compared to suburban environments, residents of traditional neighborhoods had more businesses and types of businesses within 1/4-mile. The choice of walking was most strongly driven by the accessibility of amenities and to walkways, although distance was also important. However, the researchers could not prove the differences in behavior were due to changing the built environment. Lund (2003) studied the pedestrian activity of residents in eight Portland, Oregon, neighborhoods: four traditional and four suburban. Using household surveys, she found that residents of traditional neighborhoods were more likely to walk to local shopping areas than residents in suburban neighborhoods.

Dill (2008) studied transit usage at residential developments around and near four commuter rail stations in Portland, Oregon. The respondents to her survey were asked to fill out an eight-page travel survey about their transportation choices and transit usage. With more than 300 responses, she found that most respondents were childless, predominantly

female, and had high incomes. An average of 26 percent of them reported that they used transit for a majority of their commutes. When the distances between the rail station and their homes were relatively farther, commuters continued to use transit but were likely to drive or be driven to the station. Additionally, free parking at their worksite had a negative impact on residents' transit usage. Of the one-quarter that were required to pay for parking at their work, over half used transit. This figure compared to only 17 percent of residents who used transit if they were not required pay for parking at work. Less than one-quarter of residents used transit for non-work trips, although the transit's share of non-work trips downtown was much higher. To those residents who moved to the neighborhood, an estimated 16 percent switched to using transit from another mode, and 76 percent of new residents said they did not eliminate or add a new vehicle to their household. However, 13 percent said they eliminated a vehicle due to the characteristics of the neighborhood.

Finally, Crowley, Shalaby, and Zarei compared data from 1986 and 2001 for the North York City Center located at the northern edge of Toronto to examine how the walking distance to rapid transit service "is related to mode choice and auto ownership and use" (2009, 2). The data used in their research were derived from a comprehensive travel survey called the Transportation Tomorrow Survey (TTS), which accounted for approximately 5 percent of all households in Greater Toronto. They found the number of transit riders who walked to the station was 36 percent at 200 meters (656 feet) from the station, 32 percent at 200 to 400 meters (656 to 1,312 feet), 17 percent from 400 to 800 meters (1,312 to 2,624 feet), and 3 percent at 800 meters or more. The researchers also found that households within 400 meters of the station owned 0.74 vehicles per household, rising to 0.94 vehicles per household between 400 and 800 meters, and 1.04 for households farther than 800 meters.

TOD's impact on trip generation is discussed less intensively in the literature. Friedman, Gordon, and Peers (1994) studied 1980 travel surveys from residents who lived in traditional neighborhoods and suburban neighborhoods in San Francisco, California. They found the trip generation rate was 25 percent higher in suburban neighborhoods than in traditional neighborhoods and that total travel trips by automobile were about 32 percent higher. The incidence of single-occupancy vehicles was 14 percent higher in suburban neighborhoods than

found in traditional neighborhoods, while the use of alternative transportation modes was almost double in the traditional neighborhoods. For home-based, non-work trips, transit use was almost twice as high in traditional neighborhoods, and pedestrian travel was 40 percent higher.

Sperry, Burris, and Dumbaugh's (2010) study questioned whether mixed-use developments induce trips and, if so, does the trip generation overcome the congestion relief benefits. The researchers examined a mixed-use project in Plano, Texas, called Legacy Town Center to determine if it had the effect of inducing net positive travel, as the authors hypothesized that it would. The researchers used an origin-destination, intercept study to collect data as people exited buildings. Travel data were collected during weekdays for two study periods (over the morning and afternoon peak travel periods). During the morning period, the researchers found that relatively few trips were induced (3.9 percent) and approximately 15.4 percent of the trips were internal (within Legacy Town Center). Induced trips were slightly more than one-quarter of the internal trips. During the afternoon, 44 percent of the trips were internal and 22.4 percent were induced. About half of the internal trips were induced trips and approximately two-thirds of the activity occurred between retail establishments was induced. Many of these induced trips were short walking trips.

Impacts of TOD on Miles Traveled

With two of TOD's defining characteristics being mixed-use and access to transit, it would be expected that TOD's existence in a region would reduce the number of vehicle miles traveled (VMT). While this hypothesized or actual effect may appear small to policymakers and the general public, given the very large VMT totals that exist in heavily populated regions, even a small percentage reduction has a sizeable impact. Zhang and Yi (2006), using a four-step travel demand model, predicted that a transit system with TOD in the Austin, Texas, region, would reduce daily regional person miles traveled (PMT) between 10 million and 12 million miles. As a result, the proportion of congested roadways in the region overall would drop by 2.2 percent in the year 2030. A later study by Zhang (2010) examined three TOD scenarios in the Austin region, which were: 1) base scenario, no build of a regional commuter rail and BRT

network; 2) build 10 TODs along the commuter rail line; and 3) develop bus-based TOD corridors and the rail TODs from the second scenario. Zhang's analysis found that TOD caused only a minimal diversion of commuters from single-occupancy vehicles to other modes. Likewise, there were minimal commuter shifts to the transit. However, on the entire 3-county network, he found that the rail-only TOD scenario reduced overall travel by 9.8 million PMT per day. Within this amount, the reduction of single-occupancy vehicle activity was 9.57 million miles, which reduced the average daily work commute by 3.56 miles. The more extensive TOD scenario reduced PMT by 12.4 million miles and the commute trip distance by 4.53 miles. The rail-only TOD plan also reduced the number of congested lane miles from 3,729 miles to 3,296 miles or almost 18 percent. The more extensive TOD system further reduced the number of congested lane miles by an additional 341 miles. Finally, Sperry et al.'s (2010) rough estimation of the impacts on VMT from a dense, mixed-use development in Plano, Texas, was a 14.2 percent reduction of VMT during the morning and 34.3 percent reduction during the afternoon.

Despite these findings, our understanding of TOD's impact on miles traveled is complicated by Cervero's (2006b) argument that the four-step model (commonly used by transportation engineers and planners) is an inappropriate tool for assessment. This is because four-step models are regional models that do not provide adequate granularity to accurately predict the impacts of individual projects on VMT. More specifically, Cervero points out that four-step traffic models do not account for the "co-mingling" of land uses, which has the effect of reducing trip generation due to internal capture. Cervero refers to studies by Ewing and Cervero, (2001) and the Institute of Transportation Engineers (2003), which demonstrate that the internal capture from TOD can affect trip generation by as much as 55 percent. According to Cervero, another problem is that four-step models do not accurately distribute trips across a network. Instead the models rely upon centroid connectors in the Traffic Analysis Zones (TAZs) and assumes that the length of intra-zonal trips is one-half to two-thirds the length to the nearest zone. When TAZs are in urban areas, the trips are usually shorter than the models assume. The consequence of this is a preference for automobile trips during the modal choice step, even though walking may be chosen with greater frequency. Another issue is that travel

surveys for four-step models often do not include walking and bicycling modes, so they are usually missing from the travel demand model. These models also tend to use travel time as the influence on mode choice, rather than land use at the origin and destination. Additional problems Cervero observed were that travel demand models:

- Do not account for people shifting their peak period travel to the edges of the period.
- Are missing local and sometimes collector streets in the transportation network.
- Do not assume the existence of a dynamic feedback loop between travel assignment and land use.

Unfortunately, Cervero also dismisses activity-based, micro-simulation software program like TRANSIMS as an adequate substitute, since they too are regional in nature.

Since there are limitations to using a four-step model to predict the impacts of TOD projects. Cervero provides some examples of transportation planning agencies that have attempted to overcome the problems by incorporating appropriate modifications. Austin's Capital Area Metropolitan Planning Organization (CAMPO), for example, assumed lower vehicle ownership in TODs, which reduced their prediction of trip generation and affected mode choice. Cervero also offered two suggestions for overcoming the problems of the four-step model that he has used for various projects in the United States. These strategies were post-processing the modeling results or direct (or off-line) modeling as an alternative to the four-step model (Cervero 2006b).

The Lesser Known: Bus TOD

Currie (2006) points out that the casual reader of TOD literature often considers TOD only in the context of rail transit. However, he reminds readers that Calthorpe's (1993) original New Urbanist definitions and ideals included both bus and rail transit and that Cervero et al.'s (2004) survey of TODs in the United States found that 8 percent of all TODs in the United States were bus TODs. These bus TODs are usually associated with lower densities and with busways or BRT, rather than typical bus routes with infrequent service and minimally fixed infrastructure (Currie 2006). This characterization was supported by Johnson's (2003) study of the interaction between bus transit and land use in the Minneapolis-St. Paul region.

Currie (2006) also summarized the work of other researchers who have identified various constraints to the successful implementation of bus TOD projects (and are presented in the narrative below). Dittmar and Ohland (2004) suggested that Park-and-Ride facilities limit TOD opportunities because they encourage the use of automobiles to access transit stations and reduce the opportunities for constructing adjacent TODs. Another problem has been the lack of institutional support within the transit agencies. Cervero et al. (2004) found that only 3 percent of transit agencies had a full-time staff dedicated to their bus TOD programs, compared to 42 percent dedicated to rail TOD. On the other hand, some problems that hinder bus TOD are specific to the operation of buses. For example, bus operations can limit pedestrian access to a TOD because there are a significant number of bus movements at stations. It is also more difficult to concentrate activity around bus stops than rail stations because there are many more bus stops than train stations on a route. A study by the California Department of Transportation (Caltrans 2002) observed that there were 3,400 bus stops in San Diego, compared to 49 light rail stops (Currie 2006). Currie identified other hindrances to the development of bus transit. He noted the perceived impermanence of bus routes can be a hindrance to encouraging development, although he later dismisses its practical importance. Caltrans (2002) and Dittmar and Ohland (2004), however, have argued that rail's permanence means that TOD projects are large in scale and magnitude. Some have suggested that bus riders are demographically different and would not be attracted to TOD, since they tend to have lower incomes. Yet, Currie (2005) found that busway riders in Perth, Australia, had characteristics similar to rail riders, although both of these latter groups were more "choice" (i.e., higher socioeconomic status) than street bus riders (Currie 2006).

Examples of bus TOD are diverse and are sometimes difficult to pinpoint because they range from small projects to much larger developments. Feder (2009) summarized TOD patterns along Pittsburgh's Martin Luther King, Jr., East Busway Corridor. The busway facility is a 9.1 mile, 2-lane bus-only road that connects downtown Pittsburgh at the AMTRAK station with Swissvale, a close-in suburb. The entire length of the busway is at-grade, with the exception of a 1/4-mile elevated section, and is located within a vacated portion of an operating railroad right-of-way. There are nine stations with various amenities ranging from a

simple line station to stations with aerial walkways and kiss-and-ride facilities. Since its construction in 1983 and prior to 1996, the Port Authority of Allegheny County identified 54 developments valued at $302 million that were built along the entire busway. All of this construction was either residential, office, or retail. Recently, around two of the nine stations 13 more developments have been built with a total value of $506 million. This new construction has included retail, townhomes and apartments, medical research, hotel, and office land uses.

Within Texas, Kuperman and Handy (2007) studied a less traditional form of bus TOD by examining the effect of the shuttle bus service provided by the University of Texas at Austin (UT) on residential development patterns. Their study focused on the Pleasant Valley/Riverside area of southeast Austin, which is well-served by UT shuttle buses. Already a popular area with students because of its affordability, during the early 1990s, almost 2,400 additional apartments were built. By the 2000 U.S. Census, the neighborhood had more than 8,000 students or 71 percent of its total residents. Because there was no significant increase in the enrollment at UT, most of new growth was the result of students relocating from more expensive housing west of campus or from older multifamily housing within the Pleasant Valley/Riverside area.

Kuperman and Handy (2007) found that UT shuttle buses share some attributes with bus rapid transit, although this comparison is not an ideal fit. For example, the UT shuttle buses run frequently during peak periods (between 5 and 10-minute headways), and they are distinctly marked. In some instances, they serve dedicated bus stops, although at other times the stops are shared with Capital Metro's regular service. However, unlike other bus rapid transit systems, some typical practices or technologies are not implemented, such as using articulated buses, alternative fuel sources, or electronic message boards. Yet, despite its somewhat rudimentary infrastructure, the service is viewed by students as "convenient, available, [and] reliable" (Kuperman and Handy 2007, 6). Likewise, the developers of multifamily housing found it to have sufficient permanence that they built around it without asking for any public incentives. Similarly, while the new residential development in Pleasant Valley/Riverside area has some attributes in common with TOD, it is not a perfect fit. Its TOD

attributes include density, convenient transit service, and many services within walking distance. However, parking at the apartment complexes is provided at a slightly higher rate than one space per tenant. This suggests that while transit is used for trips to UT, the students' automobiles are used for most other travel. Additionally, developers and the City of Austin have built few bicycle or pedestrian facilities at or around these projects, and there are few sidewalks on the adjacent streets. In fact, the area surrounding the multifamily housing is strip retail development and follows a single-use pattern (Kuperman and Handy 2007).

Ultimately Kuperman and Handy (2007) concluded that while the TOD in their example is not "ideal" (from the New Urbanism standpoint), it does provide medium to higher-density residential development that would not have occurred without the UT shuttle bus service. They also argued that the lack of public sector involvement, in terms of proactive planning prior to the new housing construction, led to the monolithic growth. The authors questioned whether greater public involvement would have resulted in a more desirable mixed use development with more opportunities for walking and bicycling.

Limits to Altering Travel Demand with TOD

While proponents have written extensively about the benefits of TOD, research studies have not demonstrated that changing the urban form alone significantly alters individuals' travel behavior in the United States. Boarnet and Sarmiento (1998) studied the effect of land use patterns on non-work trip generation using data from Southern California travel diaries. They argued that many of the previous studies examined aggregate data across neighborhoods and did not adequately control for the characteristics of the neighborhoods. They theorized that the "price" of travel is what determines trip mode and that "New Urbanists and related designs are intended to alter the time cost of travelling from one location to various other locations by concentrating trip origins closer to destinations and by influencing travel speed" (1998, 1157). Ultimately, however, their research findings were inconclusive, providing no evidence that land use patterns influence travel patterns but not disproving it either.

In a later study, Greenwald and Boarnet (2001) explored the connection between the built environment and walking behavior using a 1994 two-day travel diary from the three-

county area that surrounds Portland, Oregon. Using regression analysis, they found that population and retail density at the regional level did not determine individual walking behavior. Individual trip "costs" also were insignificant when analyzed at the regional level. They concluded that their findings from this study contradicted earlier studies by Boarnet and Greenwald (2000) and Boarnet and Sarmiento (1998), which found a connection between regional land use and non-work automobile travel. They argue, while there is some connection between land use and walking behavior, the relative contribution of denser land use to greater walking behavior is not clear. Instead, trip distance is the most important determinant of non-work walking behavior, with short trips encouraging more walking. Finally, Greenwald and Boarnet were skeptical that New Urbanist development has any impact on non-work walking behavior beyond the area of influence from the New Urbanist development.

Another explanation, offered by Boarnet and Crane (2001) (and distilled by Lund 2003), for the limited impact of TOD on travel behavior is self-selection among TOD residents. In other words, residents who already had a preference for replacing driving trips by walking or who are current or potential users of transit are more likely to live in a TOD project or in a neighborhood with the characteristics of neo-traditional development. In an earlier study, Boarnet and Crane (1997) pointed to Cervero's (1994a) finding that 42.5 percent of the residents in TODs were already using transit prior to their move. Similarly, Handy et al.'s (2006) study of self-selection and walking behavior referred to Handy and Clifton's (2001) study of walking behavior in Austin, Texas, neighborhoods and Bagley and Mokhtarian's (2002) study of the San Francisco, California, area, which revealed that residents attitudes and lifestyle choices had the most significant effect on travel demand and that land use patterns have relatively little impact. Lund (2003) also found evidence that residents who preferred walking to local commercial establishments self-selected into traditional neighborhoods.

In Lund's (2006) summary of previous research, she observed that Jarvis's (2003) study demonstrated that residents do not always reside in the locations they prefer. More specifically, Jarvis stated, "efforts to design 'traditional' 'village-like' compact communities are being undermined by compromises made within households of growing internal complexity (Jarvis 2003, 603). In other words, the desires and goals and households as they relate to work,

school, and recreation are creating contradictions between stated lifestyle and travel preferences and actual behavior. Likewise, Lund (2006) and Handy et al. (2006) pointed to Schwanen and Mokhtarian's (2005) cross-panel study of San Francisco area residents, which had similar findings but clarified that residents would move to their desired location if the trade-offs are not too great. Examples of these trade-offs are housing cost, housing quality, quality of schools, etc. Given that many of the studies on walking preferences and TOD or neo-traditional development occur in cities or regions with high residential real estate prices (e.g., San Francisco, Portland, Austin, etc.), it is not necessarily surprising that a number of residents who might prefer a neighborhood that is more conducive to walking could not afford to live in these desired locations.

There is also evidence that TOD residents who do not have an existing preference for using transit or walking will not necessarily change their behavior if placed into a TOD environment. Krizek (2000) argued that land use changes have little impact on household travel behavior and that residents will act according to their preferences prior to relocation. His research analyzed two-day travel panel surveys from the Puget Sound region concentrating on the survey respondents who moved at least once over seven survey periods. His findings were that more than half of the households relocated to neighborhoods with land use characteristics similar to their previous neighborhood. Twenty-six percent of the households moved to neighborhoods that were less dense than their original household, while 18 percent of the households moved to denser neighborhoods. The number of households moving from high to low density neighborhoods was significantly higher than the number of residents moving from low to high density (6.7 percent versus 3.5 percent). Using the same Puget Sound data for a later study, Krizek (2003) found the data still supported the notion that land use changes do not affect travel patterns when residents relocate. Lund et al. (2004) found no conclusive evidence that California TOD residents were more inclined to use transit between 1992 and 2003.

Lund (2003) produced evidence that residents' existing attitudes toward walking and interacting with their neighbors to be a much more important predictors of their willingness to walk than any variables describing the neighborhood. Residents were more likely to walk if they had a favorable attitude toward walking and a comfortable walking environment. These

residents also wanted opportunities to visit with neighbors, nighttime safety, as well as nearby commercial establishments. Her conclusions, she reported, were similar to the results from work by Kitamura, Mokhtarian, and Laidet (1997). A later study by Lund (2006) demonstrated that not all residents living in TOD are interested in transit access. Her survey results found that many residents of TOD projects in Los Angeles and San Diego, California, moved to them because they provided good access to highways. She also found that TOD residents in these two cities were more likely to have a vehicle than residents in the county as a whole.

There are additional questions as to whether neo-traditional development actually leads to a reduced number of automobile trips, even though residents are more likely to walk. Handy (1992) could not conclusively prove that walking trips in neo-traditional developments actually replaced trips that would otherwise be made in an automobile or that the land use generated more trips than would have otherwise occurred in a suburban neighborhood.

Some have questioned whether transit agency policies sometimes hinder TOD's ability to reduce vehicular travel. Willson and Menotti (2007) reviewed the BART's previous policy requiring one-to-one parking replacement for TOD projects. The authors believed this policy undermined the fiscal viability of many TOD projects. They identified two "conceptual blocks" held by agency leaders that have been used to justify the replacement of lost parking spaces: first, the belief that developers "owe" the agency replacement parking when building a TOD because it has lost something it once owned and second, the fear that ridership will be lost if the parking is not replaced. To counter these arguments, Willson and Menotti prepared a hypothetical analysis for the redevelopment of two BART stations, while examining three development scenarios. The first development scenario was medium intensity TOD with replacement parking. The second scenario was medium intensity TOD with reduced parking. The third scenario was high intensity with reduced parking. At both stations, their analysis found the highest intensity development would generate the greatest profitability for BART without an overall loss of ridership. The authors did acknowledge, however, the political reality of losing existing riders (by not replacing the lost parking) might impact the willingness of transit boards to pursue such a policy.

Finally, some have been critical of TOD's ability to meet its goals while operating under practical constraints. Nelson and Niles (1999) observed that existing market and socioeconomic patterns frequently run counter to New Urbanists' ideals for development, especially as they relate to retail and consumer services. Retailers, depending upon the market area they serve, may demand larger buildings than can be accommodated in a residential area. Additionally, most retailers realize that transit trips account for a very small share of total non-work trips and plan their stores accordingly (i.e., they provide parking, often a lot of it). Consumers also tend to choose non-work trip activities that minimize their total activity time and may carry-out several tasks during a single trip, which means they have a preference for large retailers and large aggregations of retailers. Nelson and Niles also questioned how much significance the public gives to New Urbanists' social goals of less segregation, a higher quality of life, and a heightened sense of community. They believe local residents are more likely to assess TODs' regional impacts on congestion and air quality, rather than the New Urbanists' social criteria. Another limitation they identified is community opposition to land use changes that lead to greater densities. These changes are often opposed in existing neighborhoods but are more likely to be accepted as part of new developments. This reality limits the ability of most cities to retrofit large areas of the urban landscape. And, even if such a massive redevelopment was allowed to occur, trillions of dollars of real estate investment have already been made into the existing urban form. Therefore, the ability of New Urbanism policies to produce a rapid change toward denser, mixed land-uses is constrained for many years into the future.

Personal Safety and Transit

The topic of crime and personal safety within transit systems is a significant one for agencies and advocates of TOD, since fears of victimization play a significant role in commuters choosing private vehicles over public transportation. Loukaitou-Sideris, Liggett, and Iseki (2002), in their review of existing literature on transit crime, point out that transit facilities create a desirable environment for criminals, since they concentrate a large number of users in high-risk populations [women, the elderly, the disabled, etc.], within a few nodes, along a transportation corridor. Transit facilities frequently create environments where transit users

have limited escape routes or find themselves in isolated locations, such as at park-and-ride facilities (Loukaitou-Sideris et al. 2002, 137).

One difficulty of conducting research on this topic is the imprecise reporting of criminal incidents. Plano (1993) argues that crime data often lacks enough specificity to determine the association between transit systems and criminal activity. Based on crime patterns in Baltimore, this researcher found that the stated location of the crime was for an area, not a specific site, which made it impossible to tell if the crimes actually occurred at transit facilities or at some other near-by location. Another issue is that most studies do not compare crime rates at transit facilities with crime rates in the general population. Yet, many of the existing studies state that the crime levels on transit systems are not significantly higher. An early study by Thrasher and Schnell (1974), using data from 37 U.S. transit agencies between 1969 and 1971, found that individuals using transit were twice as likely to become involved in a criminal incident than if they were in a non-transit situation. However, the authors cautioned their dataset had limitations, which might affect their findings. This comparison continues to be a gap in the existing literature.

According to Loukaitou-Sideris et al., characteristics of transit crime can be distilled into five common themes in research:

- It primarily occurs in major cities.
- Most transgressions are not serious crimes but petty ones and obnoxious behaviors.
- Crime levels at transit facilities are highly correlated with the crime levels in the surrounding neighborhood.
- Most incidents occur at train stations or bus stops and not within the transit vehicles.
- Fewer crimes tend to occur during peak travel hours and more crimes tend to occur during late evening and at night. (2002, 136)

In line with these observations, Pearlstein and Wachs (1982) found that during a one-year period transit crime incidents within the all-bus Southern California Rapid Transit District grew proportional to increased ridership. Their research also found that transit crimes occurred primarily along routes that traverse neighborhoods with existing high crime rates and occurred disproportionately at night. A regression analysis by Bowes and Ihlanfeldt (2001)

found that neighborhoods with denser levels of poverty, vacant housing, retail employment, and manufacturing employment had higher crime rates. They also found that transit facilities that were farther from the city center had lower crime levels.

Loukaitou-Sideris et al.'s (2002) study of crime along the Green Line of the Los Angeles rail system found that serious crimes (thefts, burglaries, assaults, rapes, and murders) were concentrated at two locations. Most of the serious crimes at suburban transit stations involved vehicles and occurred at their park-and-ride facilities. The vast majority (more than 90 percent) of crimes on the rail platform involved crime against persons, such as robbery or assault and they tended to correlate with crime levels in the surrounding neighborhood. Less serious crimes, such as vandalism, were most likely to occur at the transit station or on the transit vehicle. Transit stations with park-and-ride lots tended to have a larger share of criminal activity, but it was mostly directed toward property. Ironically, park-and-ride facilities with parking attendants had the highest crime rates.

The implications of actual and perceived crime rates within transit systems are important for planners of TOD to understand and to plan for. It should also be understood that these concerns permeate transit systems, regardless of their location. Benjamin et al. (1994) surveyed both residents and users of transit in Greensboro, North Carolina, and discovered that perceptions of crime on the transit system were significantly greater among residents in general than transit users specifically. For example, 37.7 percent of Greensboro's residents believed that waiting at a downtown bus stop was an unsafe environment compared to 8.0 percent of transit users. More residents than transit users also believed that walking downtown was unsafe (40.1 percent versus 8.4 percent). Interestingly, 19.2 percent of transit users believed that walking in the suburbs was unsafe, compared to 8.4 percent who had the same concerns about walking downtown. Interestingly, Greensboro residents were only slightly more charitable to the suburbs, with 32.4 percent stating it was unsafe to walk there too.

TxDOT's Interests and Needs

The combined results of these research findings emphasize that altering the urban form can lead to a reduced demand for vehicular travel, but only if individuals are willing to travel by alternate modes. In most instances, the residents who occupy TODs and use transit have a pre-existing preference to do so. The research also suggests there is a latent demand for more dense urban development, since there are residents who report they would prefer a neighborhood that is more conducive to walking but choose to live in locations that are not for other reasons. If the concerns of these households (housing cost, quality, living space, quality of local schools, etc.) could be addressed by developers and local governments, these changes could expand the influence of TOD on the state's transportation network. To date, TOD projects have primarily attracted unmarried individuals or childless couples who are usually professionals with higher than average incomes, demographic characteristics that have become somewhat stereotypical but were quantified in Lund's (2006) study. Generally, however, the development of TOD projects is not expected to have substantial impact on overall travel demand or commuters preference for automobiles.

The present opportunity and challenge is to understand how TOD projects currently and potentially will affect travel demand in urban environments and on the statewide transportation network and incorporate them into future planning. Assuming a static environment, Texas' rapidly growing population and its strong demand for new roadway infrastructure would likely disguise any impacts from TOD on the transportation network. However, the future transportation environment is unlikely to be static, so it is in TxDOT's interest to understand, plan, and respond proactively to the possible changes that may be brought about by TOD or other similar forms of urban densification.

IV. FOCUS GROUPS OF TRANSIT-ORIENTED DEVELOPMENT RESIDENTS

The research team conducted three focus group interviews in the Mockingbird, Downtown Plano, and Cedars Stations on Nov. 24, Dec. 1, and Dec. 15, 2009, respectively. The main purpose of the focus groups was to provide insight for assessing the impacts of residing in transit-oriented development on travel behavior. The findings will also be useful for TxDOT and cities to better plan and provide transportation services and guide TOD development.

Three rail transit stations/TOD developments were chosen for recruiting focus group participants. Each of these stations is located in the service area for Dallas Area Rapid Transit. DART TOD locations offer the greatest variety and highest level of market maturity of TOD in Texas. For participant convenience, the focus group sessions were held in the same building or in close proximity to each development. The three locations, Mockingbird Station, Downtown Plano Station, and the Cedars Station, were purposively selected to represent distinct locational characteristics.

The Downtown Plano Station location represents suburban locations. Mockingbird Station has a central city location with a high level of entertainment and dining opportunities. Retail, dining, and entertainment establishments located at Mockingbird Station attract patrons from a wide area of the Dallas region. The Cedars Station represents near-downtown urban renewal districts.

A total of 26 people participated in the focus groups, with nine in the Mockingbird Station, seven in the Downtown Plano Station, and 10 in the Cedars Station. Each group was asked questions in four categories including:

1. Opinions about living in the DFW Metropolitan Area.
2. Opinions about their Neighborhood/Community.
3. Travel behavior.
4. Perceptions toward TOD and DART.

In the following, we first describe the demographic characteristics of the focus group participants. We then report the findings according to the recurring themes found in the focus group interviews.

Demographic Characteristics of Focus Group Participants

All focus group participants were recruited from areas about a 1/4 mile from the three DART rail stations. Most of them live in the study areas, though some in each group work in the TOD and reside elsewhere. Together, there is a good mix of focus group participants in terms of race/ethnicity, age, gender, and travel modes. However, there are some notable differences in demographic characteristics and travel modes across the three focus groups.[1]

All participants in the Mockingbird Station group are Caucasian. The majority of the focus group participants are middle age and older, with a few young professionals. The group is almost evenly divided in gender, with five females and four males. The group is also mixed in travel modes, with some private vehicle users, some transit users (specifically DART rail), and one bicycler.

Similar to the Mockingbird Station, all but one participant in the Downtown Plano station focus group are white, the exception being a male African American. The group is made up of mostly middle age adults with a few young professionals. There are only two females, and only two of the participants identify themselves as transit users. There is no bicycler in this group.

Unlike the previous two groups, the majority of the participants in the Cedars Station focus, who were all residents of the South Side on Lamar development, are African-Americans. Less than a third of the participants are females. Many work in the South Side on Lamar building; a few also live in South Side on Lamar building or an adjacent building. All but one participant knows each other from working or living in the building. The age range of the participants seems to be from early 20s to mid- or late-50s. Most of them are active users of public transit. Because they know each other, they were very friendly and talkative during the focus group discussion.

[1] Participants were not asked to provide specific demographic data. The characteristics reported here are based on observation.

Significant Changes in the DFW Metropolitan Area

Traffic Congestion

In our opening question, we asked if participants have noticed any significant changes in living in the Dallas area over the past five years. Traffic congestion was mentioned in all three groups. For the most part, participants perceive traffic as worse than ever. Projects such as the Mixmaster, 75, and North Central Expressway were referenced multiple times in each session, usually in a negative way. Traffic seems to be perceived as the worst during evening rush hour. "Traffic is worse than it ever was!" "To get around … during 4 to 6 p.m. in the evening, has gotten nearly impossible in the last five years." "Dallas had more drivers." "New traffic is making it easier to jump on the rail and go." "I left Arlington because of traffic." "The highways get bogged down; they're crawling; it is frustrating." These are some statements that reflected some participant's views and generated agreement among other participants.

The situation is not limited to highways, as participants noted local street congestion having worsened over the last 5 years. Metaphors such as "a Bermuda Triangle" were used in attempts to successfully describe the difficulty of the situation.

Growth

Another change identified by all the groups is growth, a factor contributing to traffic congestion, although the specific type of growth may vary slightly from group to group. The participants in the Mockingbird Station attribute increase in population, apartment, and constant roadway construction as causes of traffic congestion. One participant even mentioned that "SMU may cause traffic problem." The participants in the Downtown Plano Station saw large urban outbound expansion toward the north and growth in outdoor malls. "Everything seems to be heading north." There are "blossoming outdoor shopping malls." "Plano and McKinney all grown together." In the Cedars Station, some mentioned "residents increase around rail." "The city has grown." "Metroplex is blown up as far as population and traffic is involved."

Demographic/Social Changes

Changes in demographic composition and activities around rail stations were noted in all three focus groups. The participants in the Mockingbird Station group found more transient people in the area, referring to both the high turnover rate of apartment renters, as well as panhandlers, tweekers [drug users], and meth users hanging around the area. The group also had a relatively lengthy discussion about change in crime rate with no agreement. For example, someone stated that "the Mockingbird Station has the highest crime rate." But another countered that "the homeowners association noted less crime."

One participant in the Downtown Plano focus group noticed change in diversity. He stated that "DART has shown me how culturally diverse Dallas has become, with one DART ride now being an opportunity to hear a number of different foreign languages."

The Cedars focus group participants noted a connection between higher gasoline prices and increases in DART's ridership and parking around the station. The group also noted changes (businesses/activities) around the station. Some observed that more people are coming into the city to do things, and it is getting more difficult to find parking spaces at the train station. Other comments include:

- "Perception of inner city areas is starting to change with influx of more affluent whites;" there were "ghetto before, now the area is seen as urban."
- "These days it is very hip to be urban, everybody wants it. Black folks make a city a 'ghetto' but white folks moving in make it 'urban.'"
- "South Dallas may turn to gentrification as well."

Impacts on Travel Behavior

Information about impacts on travel behavior is generated from a number of questions regarding current travel mode, recent changes in travel mode, and participants' preferred mode of travel and reasons for their preferences.

Travel Destination

When asked how the changes in DFW Metroplex have affected their way of travel and residential decisions, the responses were mixed. A few participants indicated that traffic

congestion did affect their choice of travel destination. One participant in the Mockingbird focus group said that because of traffic, he has decided to have his lunch locally, rather than driving to somewhere else to eat as he did before. A few mentioned that they purposely avoid shopping at the Mockingbird Station and rather go to North Park because it's difficult to find parking. "You have to go into the cave [parking garage] and you're gone forever." This metaphor depicts the difficulty and frustration of finding parking in Mockingbird Station and seemed to get the most interest from the group with nods. There seemed to be an overall feeling that while Mockingbird Station was meant to have convenient shopping, dining, and entertainment for residents, it really does not have a pedestrian-friendly design.

A few participants in the Cedars group talked about the limitation of transit and how the limitation has affected their travel destination:

- "No rail connection to Arlington causes me not to go there."
- "I can't go to downtown or to Fort Worth for drinks because the trains stop running too early [in the evening]."

Travel Mode

Although most agreed DART was the best way to get Downtown during rush hour and for evenings on the town/special events (and expressed interest in using the DART rail system), they would still choose to travel by car. Reasons included that they don't want to use transit or don't know the system; the system does not get them where they need to go; schedule limitations due to the train schedule; or they have safety concerns. The phrase "I would …, but …" occurred frequently, and it reflects the common sentiment about mode choice decisions of many participants. The following are some of the statements about mode choice of the participants and reasons for their decisions:

- "I don't want to take the time to learn how to use the system; too complicated."
- "I would use DART during major work hours, more trains, people and it feels safer."
- "Different people ride the train at night. It is not safe."
- "I work in McKinney and there is no access."
- "I work at a high school and drive along George Bush Turnpike against the flow of traffic…it's a very easy commute."
- "The train schedule lags the closer you get to downtown, so I drive."

- "Can't take the train when going to 635 and the tollway."
- "It takes 5 minutes on the highway to get to my work place in Downtown…30-40 minutes if I took DART…there's no good direct route."
- "I travel all over the Metroplex for my job, and it's not practical to use transit."
- "I drive to the airport, and there's no direct route via train."
- "It's faster to drive during periods between rush hours; DART is faster during rush hour unless it stops too long or gets off schedule, which happens a lot. I can't depend on it."
- "I don't want to ride the train at night if I have to work late."
- "Cars are much faster than trains."
- "At places you may get jumped or scared if you go to the wrong area (by train)."

Rail, but no Buses

When asked about what would be their preferred travel mode if there is a choice, most participants responded that they would prefer to get around by train. Reasons for preferring train include:

- "The train is easier on my peace of mind."
- "I can read the paper and decompress."
- Prefer not dealing with traffic, nice break from driving, on time (reliable and dependable), read a book.

However, the participants also mentioned numerous improvements that would have to occur:

- Would use TOD park and ride if there is more security (smashed windows).
- Would use if easier to put bike on the train.
- Better handicap access.
- If more cross-town services.
- Need express trains that go to work centers.

Interestingly, it was clear that although participants liked the convenience of not having to worry about parking or gas, many of them said they would not use the bus because of the following:

- “Buses are a different beast.”
- “It’s too slow and there are too many stops.”
- “I don’t feel safe on the bus.”
- “Buses are still stuck in traffic while the train is separated.”
- “Trains are comfortable and cool, [but buses are not].”
- “The bus is not good anywhere. Buses use roads with the rest of cars.”

Opinions about DART

All three groups talked about DART’s services. However, the comments about DART are mixed. Some observations are described below.

The Paradoxical Views about DART

Public Transportation’s expansion and increase in ridership was a popular topic in each group, though different groups focused on the subject at seemingly random and distinct points. The system has mysteriously gotten easier and more difficult to use, according to the participants’ collective feeling. Scheduling was a controversial topic, as disagreement in the conversations occurred with regard to running trains and expanding routes. Here are some conversations reflecting the paradox:

- “DART [has] gotten easier to use.”
- “The system is efficient.”
- But “you can’t buy tickets with your card.”
- “The [ticket?] machine is always broken.”
- “When I go downtown on light rail, I noticed since the green line opened the schedule is not as well kept as it was.”
- “We joke it’s because they never had a schedule.”
- “Now they keep a schedule but trains are never where they are supposed to be and you notice 20 minute delays between stops.”

Safety and Security

Safety/security is probably the major problem with DART in participants' eyes, eliciting a lot of emotional responses and metaphors. DART is not perceived as a viable transportation option except for those who work downtown—though there is a sense of guilt for not using the transit system more.

A majority of focus group participants cited safety as the biggest problem that keeps them from using the DART system to their work place. They gave a number of visual cues such as leaning forward in their seat and waving their hands that confirmed how important this issue was to them. People felt safe riding the train during peak hours and events because of the mass of people on the train; but, off peak, the lack of security made people uncomfortable on the train. One person commented that on other transit systems around the world (such as the subway in New York) you feel safe and don't question it like you do on DART. Another participant mentioned that maybe transit cops could "actually ride the trains instead of sitting in their cars at the station. It's surprising that more cops are not riding to increase security and checking fares of riders."

Orientation and Direction

Knowing where and how to go places was a big concern. Comments included:

- There was "no map at the station clearly telling me what line I'm getting on and where I'm going."
- "The stations don't provide a good sense of direction. When riding in other cities such as New York, Paris, or Chicago I can figure out the system."
- "I can get around easier in a foreign county with a different language than I can on DART."
- "We were new to the system, and it was hard to figure out what to do."

Needed Improvements

Expansion of routes and schedules, accessibility to families, and prevention of mechanical failures of trains and ticket dispensers are included in participants' ideas for improvement of the system. For instance, for parents with toddlers, the DART line is "simply

and totally not an option." Likewise, DART remains unfriendly to bikes despite installation of some bike racks on their bus fleet.

Overall, if it were made easier to understand and if people were available to answer questions about how to ride the train and where it is going, "then it would be more appreciated and utilized by this community... people have to feel safer before they will use it more." Extensions to employment centers and better connection would also aid in the further adoption of the system. DART is encouraged to "plan hard and plan well," with special emphasis on impact studies for surrounding neighborhoods.

Politically, DART should help cities come up with the tax money, since sales tax pays a lot of DART. Small cities have to pitch in too. An overall impression of "DART doesn't care" could be remedied through physical redesign of stations, DART police patrols, and making it easier to report crimes and offenses. Many heinous acts, such as muggings and vandalism, take place in DART rails, buses, and parking lots. A couple of the participants had been victims of these crimes. It appears to the participants that DART lacks in common sense and efficiency. Expectations are simply dependability and safety.

Decisions on Residential Location

Accessibility

When asked about what they like the most about their neighborhoods and why they choose the neighborhood where they live now, two common themes came out from all three groups. The most noticeable one is ***accessibility*** to amenities. This is sometimes regarded as ***convenience***. For example, one participant of the Mockingbird Station group said "it has everything," and others supported that statement with "you said it!" Then the group started listing the amenities such as parks, restaurant, ability to walk, easy access to Katy Trail, theater, and downtown areas. Woodall Rodgers provoked the most interest and conversation. Similar statements were made by participants in the other two groups. "I like the convenience of being able to do stuff, [such as] take the DART to the Angelica." "I love not needing a car." "I walk around and shop." Mockingbird Station is centrally located, has food, entertainment, easy access to downtown that has something for everyone, including civic focus on the arts.

Sense of Community

Another recurrent theme from all focus group discussions is sense of community. This is especially true with the Cedars group. When asked what they like the most about their neighborhood, one responded by "the people" in the community. "Individuality," "freedom of expression," and "real community feel" are other words used by the focus group participants to describe the neighborhood. Other statements, such as "we wouldn't be accepted in other neighborhoods" and it is "the UN of Dallas," also reflect the perception of the participants about the neighborhood. Similar statements, such as "people know me and greet me by name," "people are neighborly," "most of the new comers are nice people," "it is a friendly neighborhood," "people say hello to each other," "we are all city people here," etc. were also heard from the other groups.

Others

A number of additional reasons were mentioned, though not in every focus group. In the Mockingbird Station group, the active neighborhood associations provoked lively discussion of their role in crime prevention and building community through neighborhood activities. Other reasons, such as ability to ride bikes to work, investment, good housing design, etc. were also mentioned.

Downtown Plano participants liked their neighborhood having a small town feel near a bigger town. They enjoyed having the option to go to downtown and the Angelica (arts movie theater located at Mockingbird Station), but they also loved the local shops where people greeted them by name. "It is an urban feel but not city life and expenses." The Cedars group liked that it wasn't a "Cookie Cutter" neighborhood.

Perception toward TOD

Very few focus group participants knew about the term "Transit-Oriented Development." Among the 26 participants, only three knew the term before being contacted for the meetings.

When asked if TOD is good or bad for them and their neighborhood, some acknowledged the benefit of having an alternative to driving and being able to control commute time by living in the transit service area. However, concerns about increase in traffic, rent, and high density, lack of space and kids friendly amenities, lack of identity, etc. were felt by many participants:

- "I won't live in one since I have kids."
- "Prices in TODs are ridiculous, might as well live in uptown."
- "I prefer it as a single person."
- Good idea but not enough development to support it.
- TOD in downtown Plano is causing an identity crisis – losing historic but trying to keep it with the development.
- Too much density…great to visit but wouldn't want to live there.

When asked about what may attract people to TOD, many responded with a number of suggestions including better planning and coordination of development, increased safety and affordability, good transportation, and improved marketing of both transit services and residential options.

Good Master Planning

Participants saw some missing elements in their current neighborhood and a need for a more holistic approach to the development of TOD. Some examples of the shortfalls include the lack of:

- Amenities and conveniences by foot, such as drug store, 24-hour grocery store.
- Kids-friendly facilities such as swimming pool.
- City services such as libraries and a Post Office.

Quips about the current problems in planning include:

- "The left hand should know what the right hand is doing."
- "DART has only succeeded in forming a camel when it wanted/needed horse."
- "Too much of Plano's recent development has been without vision, without understanding what its 'civic identity' is."

Some suggestions about good examples of TOD elements and planning/development approaches include:

- Look at other benchmark cities.
- Promote dialogue with stakeholders, municipalities, and developers.
- "Look at how a Wal-Mart can work in a TOD."
- Need more holistic approach with inclusion of parks and green space.
- Share knowledge.
- "Addison Circle did a good job with mix" (of live/work/play clusters in one place that is walkable).

Safety and Affordability

Focus group participants saw safety and affordability as important attractions to TOD:

- "Improve safety, [and] you don't worry about crime in Sundance Square in FW."
- Apartments need to be affordable for middle class incomes, not higher income earners only.
- Cost of living needs to be lower at TOD.
- Affordable housing for retired people and lower expenses.

Better Transportation

As seen in the previous section on DART, focus group participants were highly engaged and interested in transit services. They saw many problems and had numerous suggestions for making TOD and transit attractive. Many of their comments and suggestions are similar to the ones mentioned before. Their statements about transit problems and suggestions for improvement are categorized below.

Safety

- "I didn't get mugged using city transit until using the DART system."
- The train is protected up to a certain point mainly within the more affluent areas of North Dallas and Collin County.
- "LA has numerous officers in plain clothes on trains to stop the 'clowning' that occurs on the trains; Dallas needs more officers."
- "Some stops (mainly buses) are dark and scary."
- On the train "sometimes I feel like I'm sitting next to an axe murderer."

- "People smoke dope on the train, and there is no enforcement. Cops sit in their patrol cars, and there is no coordination between transit cops and city police."

Train Schedules, System Guide, and Convenience

- "There are no human beings to talk to at stops, and you never get a hold of someone when you call DART."
- "Make it easier to get tickets; right now there are only a handful of stores to buy them at, and it's not convenient."
- Create other avenues for service.
    - Bike racks a good idea.
- DART needs to educate the general public to understand how to ride the system.
- Need more headways and later running hours.
- Buses are never on time.

Family User Friendly

- Currently it's a hassle to ride the train if you have kids (families are big in TX).
- Most parents don't want to expose children to what's on the train; some of this has to do with stereotyping and racism.
- The train can be a conduit for understanding between classes and race (the UN of Transportation).
- Kids are excited about riding the train (like to go to the zoo), but it's a lot of work for the parents.

Marketing

The participants suggested that the city, chamber of commerce, and other organizations should market and promote this type of development. However, before this can be done, they point out that the TOD must be a dependable product where all households can find quality housing, have easy access to basic amenities such as pharmacies, schools, and grocery stores, belong to a community, and have access to transit systems. Transit must be also able to reach employment centers and regional shopping centers as quick as, or quicker, than a car.

V. SURVEY OF TRANSIT-ORIENTED DEVELOPMENT RESIDENTS AND CONTROL GROUP

The Survey Research Center (SRC) at the University of North Texas undertook two surveys to provide an assessment of the comparative travel behavior of transit-oriented development residents in the Dallas, Fort Worth, and Austin areas with transit rail services. A mail survey was conducted for residents of TOD projects along with a separate telephone survey of a control group population.

Using information from the inventory of TOD projects as the study population, a sample of 3,000 households were selected for inclusion in a four-wave mail survey that commenced on May 21, 2010. The cut-off for final responses to the survey was July 22, 2010. The TOD resident survey covered several topical areas including:

- Work status.
- Travel mode for work, shopping, and entertainment.
- Work commuting patterns.
- How resident travel behavior changed after moving into a TOD project.
- The reasons for moving to a TOD project.
- Their views on several transportation issues.

Appendix 2 includes the survey instrument.

Response rates to the TOD resident mail survey ranged from good to very good for an unsolicited mail survey. As shown in Table 4, the return rate for the Dallas area was 11.4 percent, 13.9 percent for Fort Worth, and almost 20 percent for Austin.

Table 4. TOD Residents Response Rate to Mail Survey

Population Group	Pieces Mailed	Responses	Response Rate
Dallas	1,162	132	11.4%
Fort Worth	1,161	161	13.9%
Austin	677	134	19.8%
Total	3,000	427	14.2%

To provide a comparison group for the mail survey participants, SRC conducted telephone interviews with 300 residents from each of Dallas and Collin Counties. Dallas and

Collin Counties have had transit rail service for longer than any other area in Texas; therefore, this population provides the important characteristic of likely being familiar with transit rail services and being able to report behavior that does not reflect the novelty of newly opened transit rail systems. The survey used random digit dialing to select participants. The control group survey examined several characteristics for comparison with TOD residents including work status, travel mode selection for work and other purposes, travel to work distances, and sentiment toward transit rail services. Appendix 1 lists the control group survey questions.

Sample Characteristics

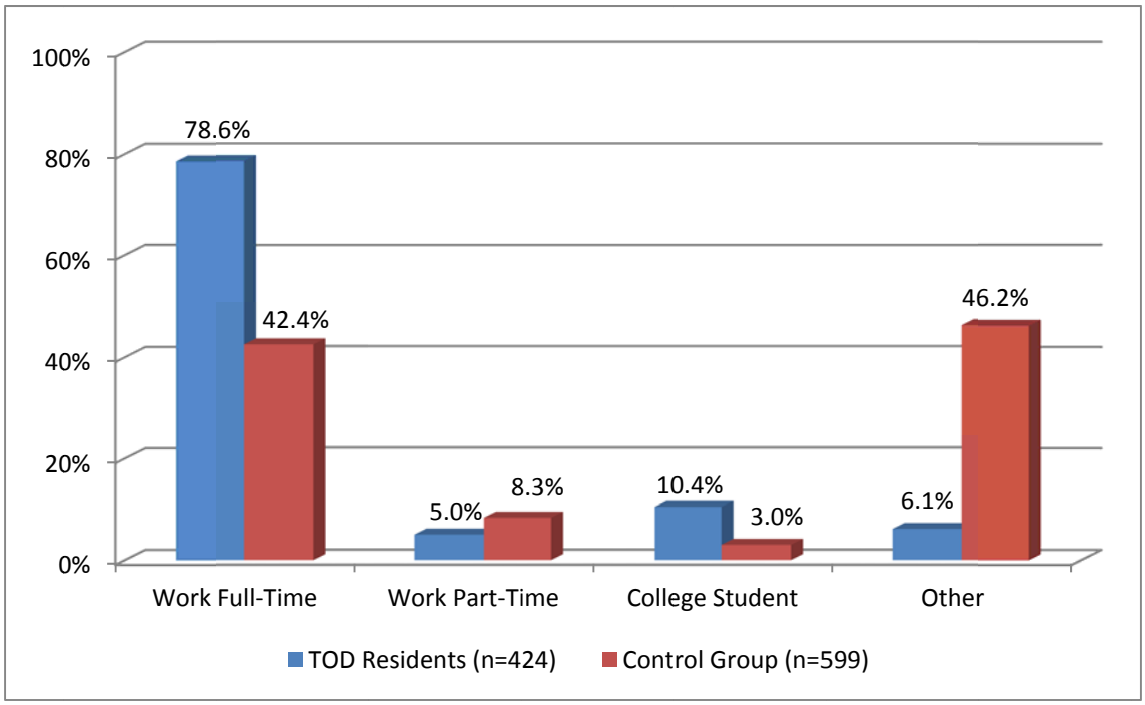

Figure 12. Personal Situation of Survey Respondents. *Note: $p < .001$*

- Respondents were asked about their personal situation. Seventy-nine percent of TOD residents and 42.4 percent of control group respondents reported working full-time.
- Five percent of TOD residents and 8.3 percent of control group respondents reported working part-time, and 16.5 percent of TOD residents and 49.2 percent of control group residents indicated they were either a college student or had some other personal situation such as homemaker, retired, or unemployed.
- In Austin, 24.2 percent of TOD residents were students compared to 10.4 percent in the combined TOD sample area.

Commuting to Work

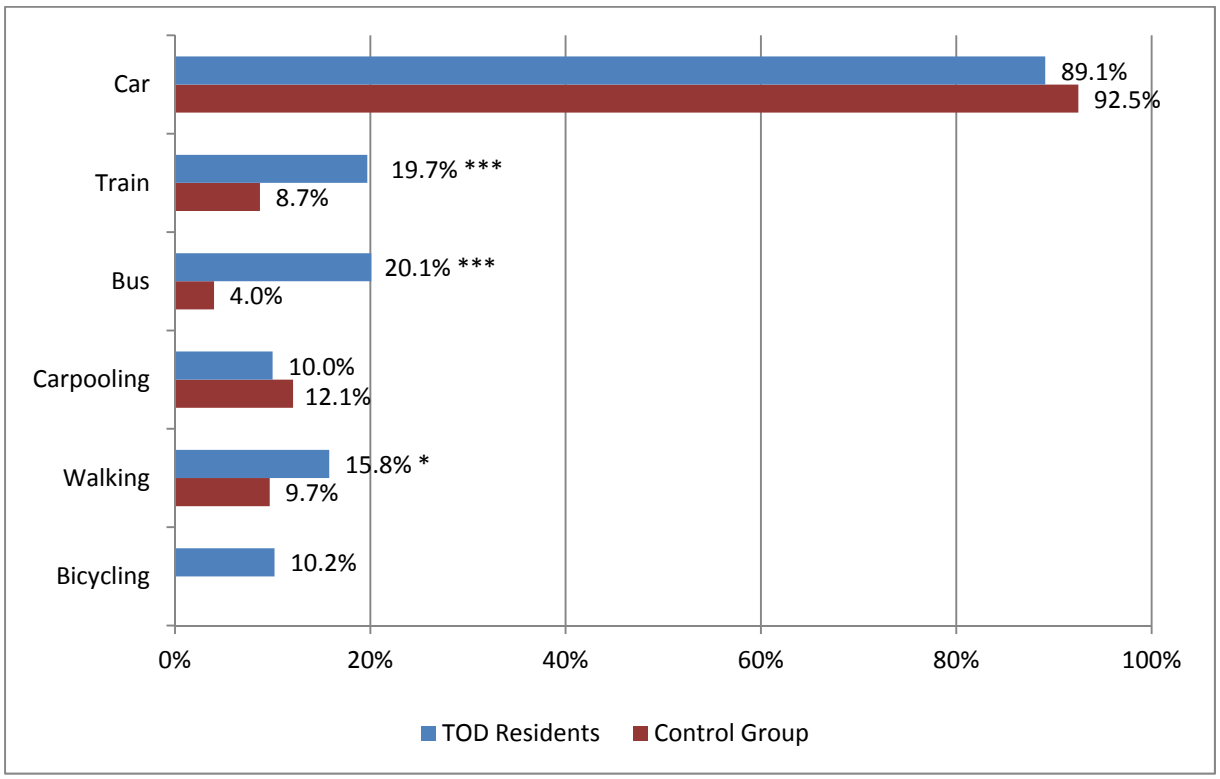

Figure 13. Methods of Transportation to Work Used by Survey Respondents. *Note: Only TOD residents were asked about bicycling. The number of respondents for TOD residents and control group are: Car 402, 322; Train 402, 321; Bus 402, 321; Car/Vanpool 400, 321; Walked 398, 321; Bicycle 402. * p < .05 *** p < .001*

- Respondents were asked if they had ever used different modes of transportation to get to work in the past 12 months.
- Among control group respondents, driving their own car was the most common method of transportation (92.5 percent), followed by carpooling (12.1 percent). Other methods were used by 10 percent or fewer of control group respondents. In contrast, although personal cars were used by most TOD residents (89.1 percent), alternative methods of transportation were used by more TOD residents than control group respondents (See Figure 13).
- Twenty percent of TOD residents compared to only 8.7 percent of control group respondents reported using a train to get to work in the past 12 months. TOD residents from the DART area were most likely to use the train to get to work (33.1 percent).
- Twenty percent of TOD residents also reported using the bus while only 4.0 percent of control group respondents had used the bus in the past 12 months. TOD residents from the Austin area were most likely to have used the bus (43.9 percent).

- Other transportation methods were used less often: Carpool (10.0 percent of TOD residents and 12.1 percent of control group respondents), Walked (15.8 percent of TOD residents and 9.7 percent of control group respondents), and Bicycle (10.2 percent of TOD residents).
- Among the 10.2 percent of respondents who reported riding a bicycle in the past 12 months, TOD residents from the Austin area were most likely to have done so (21.1 percent).

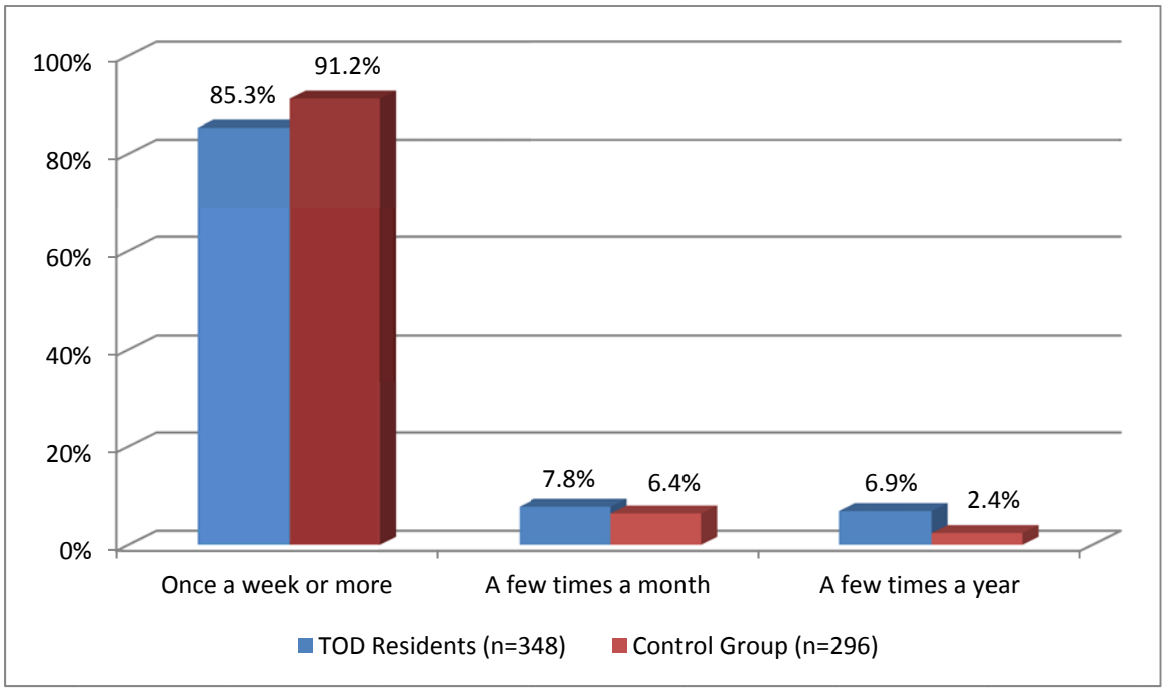

Figure 14. How Often Survey Respondents Drove a Car Alone to Get to Work. *Note: $p < .05$*

- Respondents who reported driving a car alone in the past 12 months to get to work (89.1 percent of TOD residents and 92.5 percent of control group respondents) were asked how often they drove their car alone.
- As shown in Figure 14, 85.3 percent of TOD residents and 91.2 percent of control group respondents had driven their car once a week or more in the past 12 months.
- On average, TOD residents who drove their cars to work did so less often (212 times per year) than control group respondents (235 times per year).

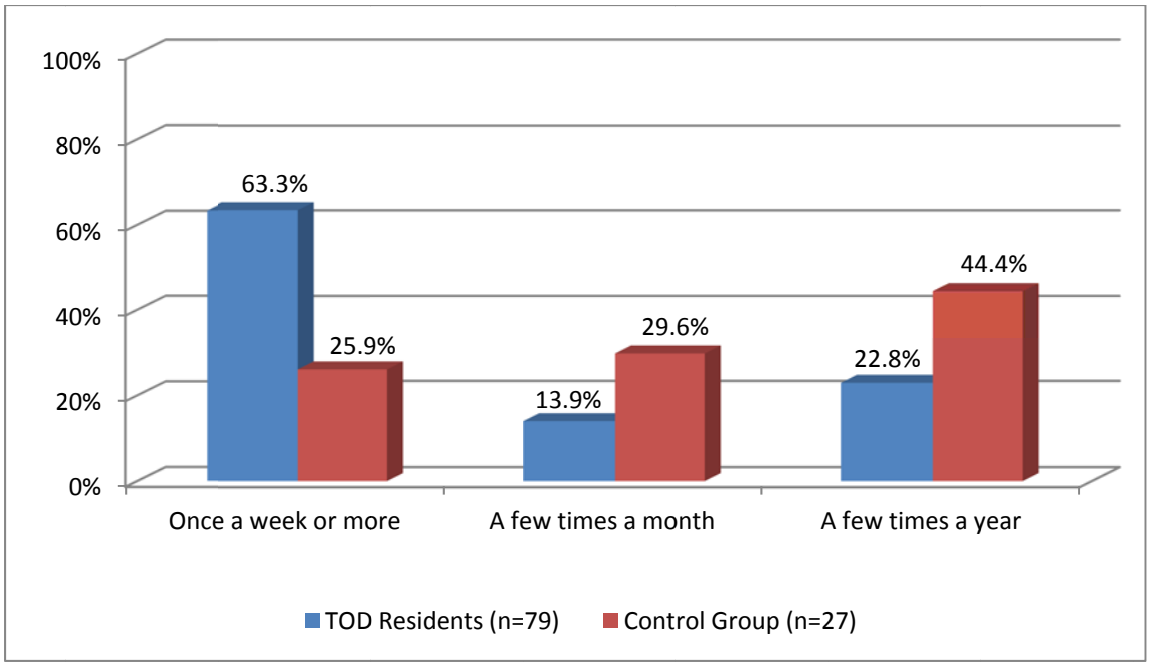

Figure 15. How Often Survey Respondents Used a Train to Get to Work. *Note: **p < .01*

- Respondents who reported using a train in the past 12 months to get to work (19.7 percent of TOD residents and 8.7 percent of control group respondents) were asked how often they used a train.
- As shown in Figure 15, 63.3 percent of TOD residents and 25.9 percent of control group respondents reported using a train once a week or more in the past 12 months. On average, TOD residents who used the train to get to work did so more often (145 times per year) than control group respondents (73 times per year) in the past 12 months.
- Respondents who used a train in the past 12 months were asked how they got to the train stop. As shown in Table 5, 85.5 percent of TOD residents walked compared to control group respondents who were more likely to use a car to get to the train stop (60.7 percent) than TOD residents (7.9 percent).

Table 5. Methods of Getting from Home to Train Stop

	Percentage Responding***	
	TOD Residents	Control Group
Walk	85.5	17.9
Drive car	7.9	60.7
Dropped off by someone else	2.6	10.7
Bus	0.0	7.1
Bicycle	3.9	3.6

*** $p < .001$

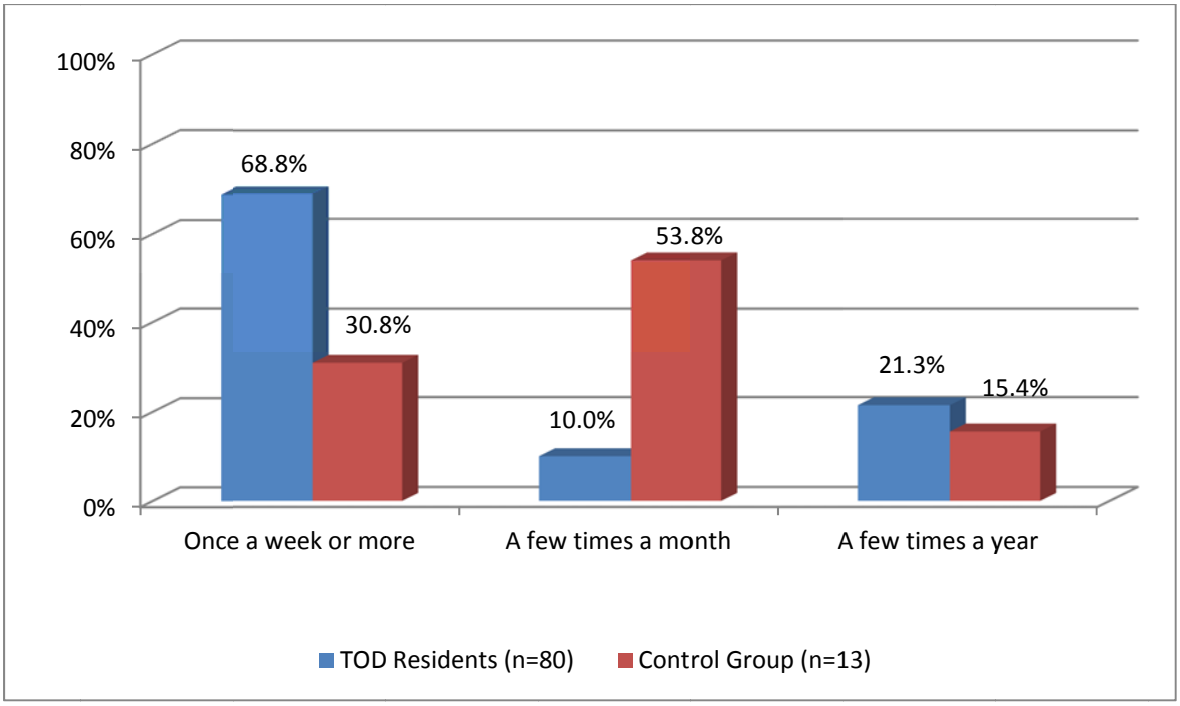

Figure 16. How Often Survey Respondents Used a Bus to Get to Work. *Note: $p < .001$*

- Respondents who reported using the bus in the past 12 months to get to work (20.1 percent of TOD residents and 4.0 percent of control group respondents) were asked how often they used the bus.
- As shown in Figure 16, 68.8 percent of TOD residents and 30.8 percent of control group respondents reported using the bus once a week or more to get to work during the past 12 months. TOD residents in the sample who rode the bus reported riding the bus an average of 136 times per year compared to 87 times for control group respondents.
- TOD residents who used the bus in the past 12 months were asked how they got home from the bus stop. Similar to the train stop data, 84.7 percent of respondents walked home from the bus stop (see Table 6). This question was not asked of control group respondents.

Table 6. Methods Used by TOD Residents to Get Home from Bus Stop

	Percentage of TOD Residents
Walk	84.7
Drive car	2.8
Dropped off by someone else	0.0
Train	9.7
Bicycle	2.8

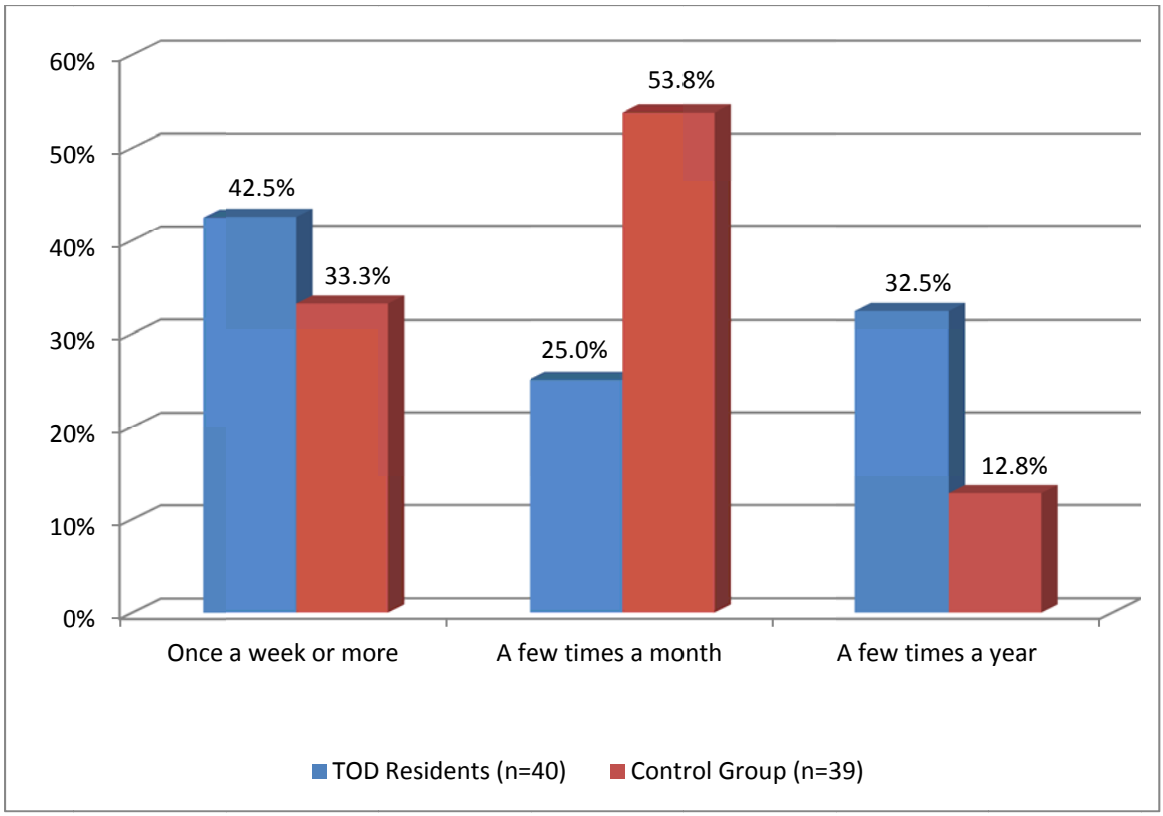

Figure 17. How Often Survey Respondents Carpooled to Get to Work. *Note: $p < .05$*

- Respondents who reported carpooling or vanpooling in the past 12 months to get to work (10.0 percent of TOD residents and 12.1 percent of control group respondents) were asked how often they carpooled or vanpooled.
- As shown in Figure 17, 42.5 percent of TOD residents and 33.3 percent of control group respondents reported using a carpool or vanpool once a week or more, while 25.0 percent of TOD residents and 53.8 percent of control group respondents reported using it a few times a month.
- The differences in the average number of times per year using a carpool were not statistically significant.

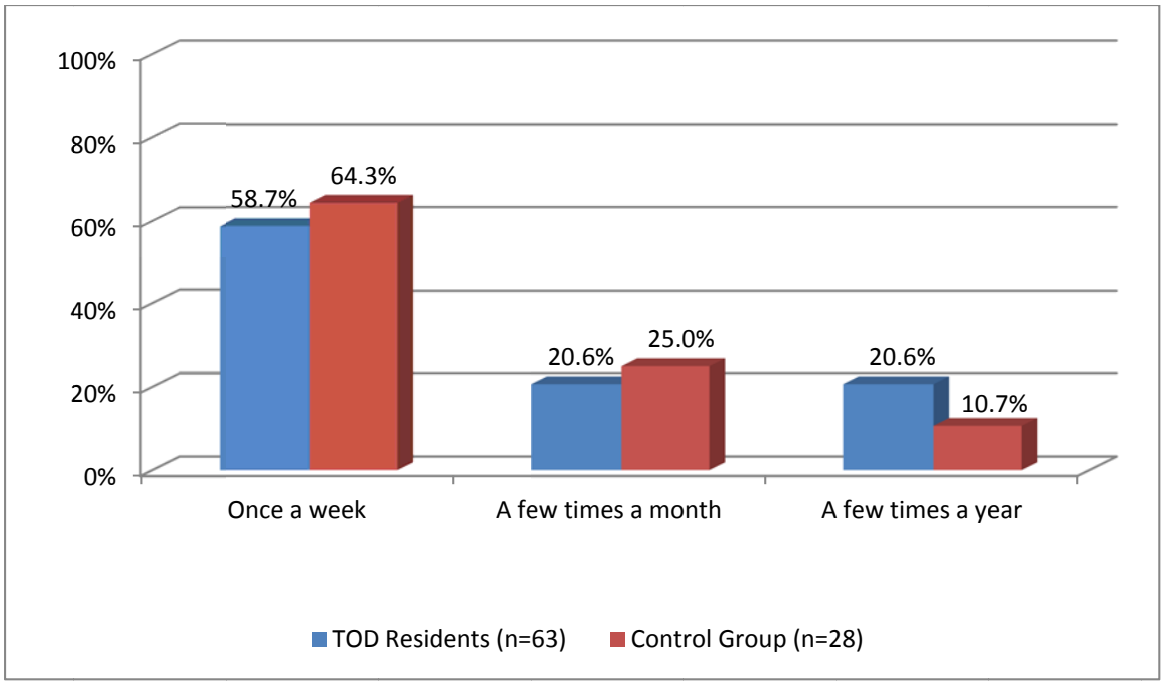

Figure 18. How Often Survey Respondents Walked to Get to Work.

- Respondents who reported walking in the past 12 months to get to work (15.8 percent of TOD residents and 9.7 percent of control group respondents) were asked how often they walked to work in the past 12 months.
- As shown in Figure 18, 58.7 percent of TOD residents who walked to work and 64.3 percent of control group respondents who walked to work reported doing so once a week or more during the past 12 months.
- Differences between TOD Residents and Control Groups respondents shown in Figure 18 are not statistically significant.

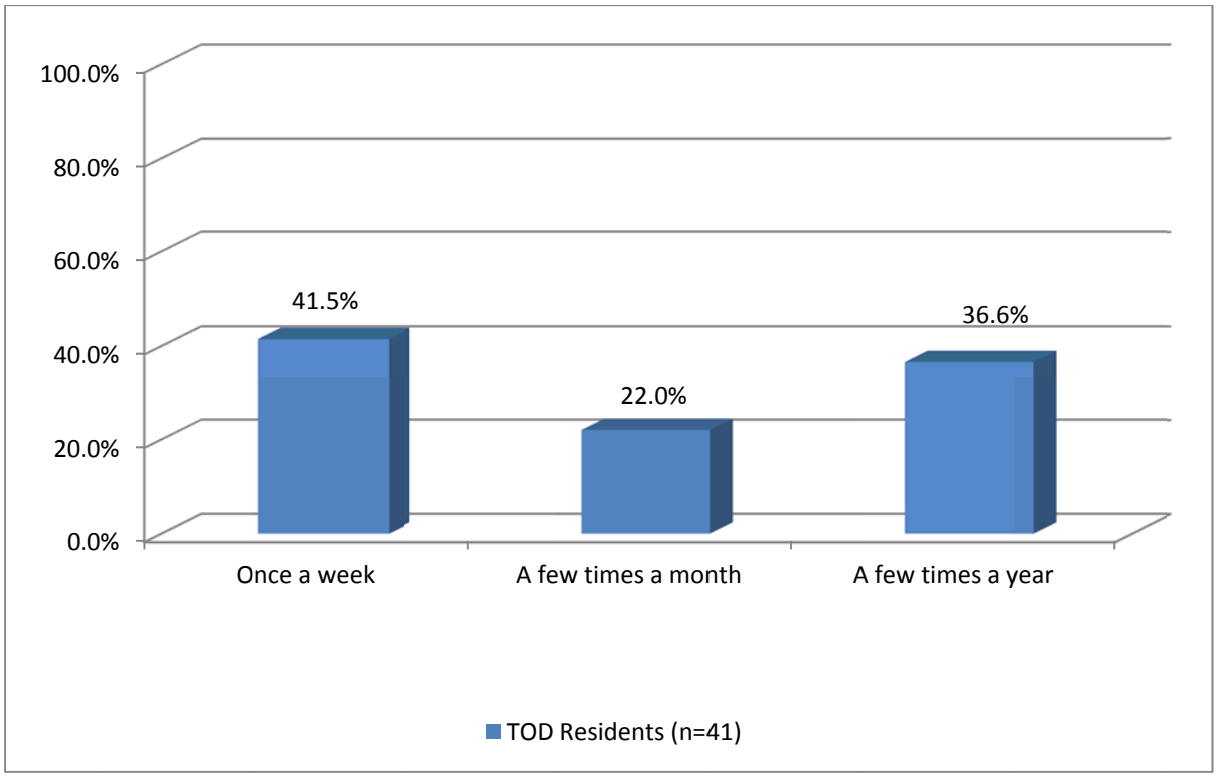

Figure 19. How Often TOD Residents Used Bicycle to Get to Work. *Note: Only TOD residents were asked this question.*

- TOD residents who reported using a bicycle in the past 12 months to get to work (10.2 percent) were asked how often they used a bicycle to get to work in the past 12 months.
- As shown in Figure 19, 41.5 percent reported using a bicycle to get to work once a week or more. Twenty-two percent reported using a bicycle to get to work a few times a month, and 36.6 percent used it a few times a year.

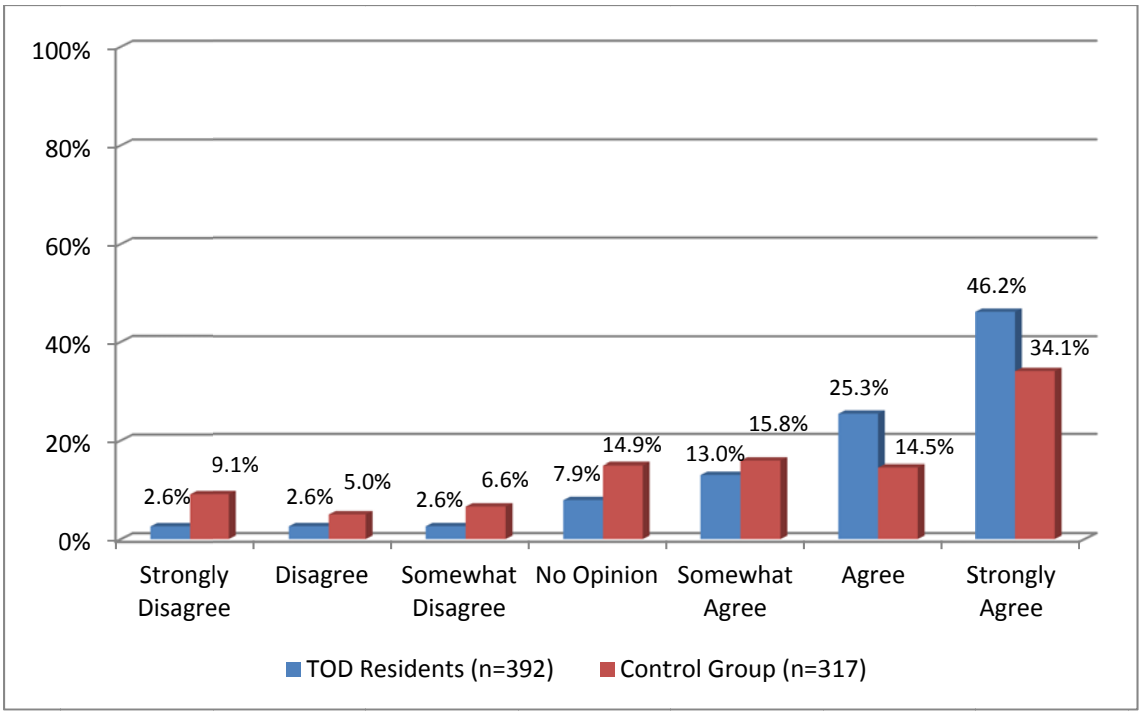

Figure 20. Survey Respondents Who Like Idea of Taking a Train System to Get to Work. *Note: $p < .001$*

- Respondents were asked to rate their opinion on this statement: "I like the idea of taking a train system to get to work." Respondents answered on a scale of 1–7 where 1 is Strongly Disagree, 2 is Disagree, 3 is Somewhat Disagree, 4 is No Opinion, 5 is Somewhat Agree, 6 is Agree, and 7 is Strongly Agree.
- As shown in Figure 20, 46.2 percent of TOD residents and 34.1 percent of control group respondents reported that they strongly agree with the statement.
- The mean answer for TOD residents was 5.87 and the mean answer for control group respondents was 5.03.

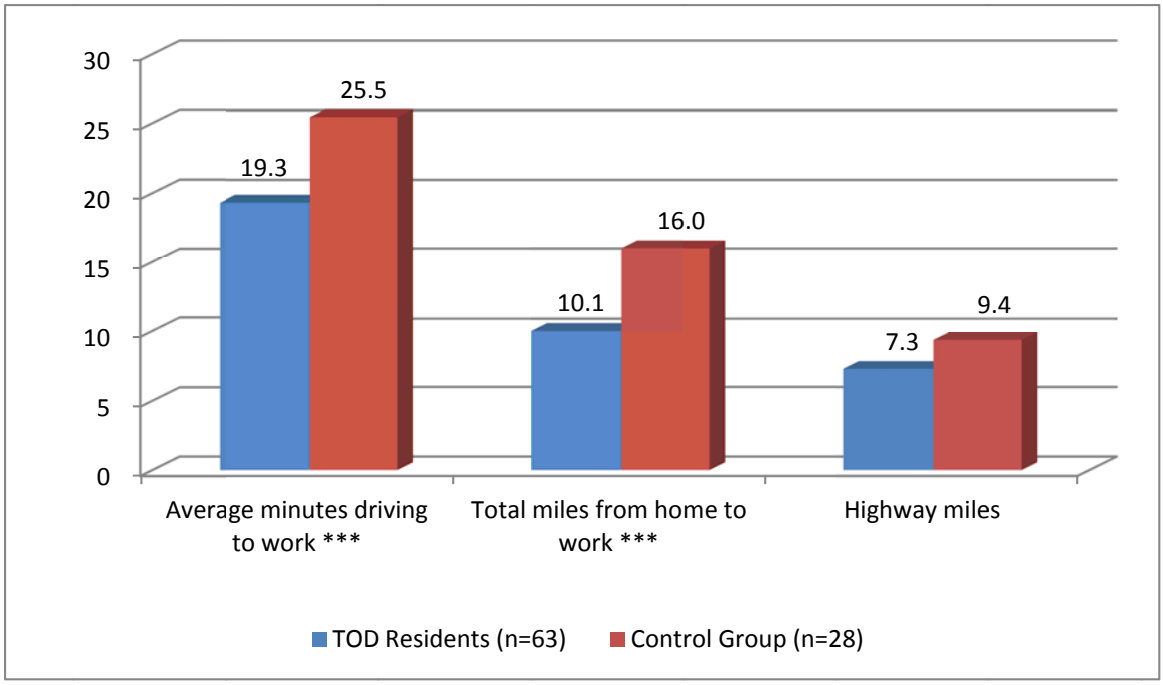

Figure 21. Average Time and Distance for Survey Respondents Driving to Work. *Note: ***p < .001*

- Respondents who reported driving their car to get to work were asked about the average time and distance they drove.
- As shown in Figure 21, TOD residents drove for less time (19.3 minutes) than control group respondents (25.5 minutes) to get to work.
- TOD residents also drove a shorter distance to get to work (10.1 miles) than control group respondents (16.0 miles), and fewer of the TOD residents' miles were highway miles (7.3 miles) than control group respondents (9.4 miles).

Other Travel

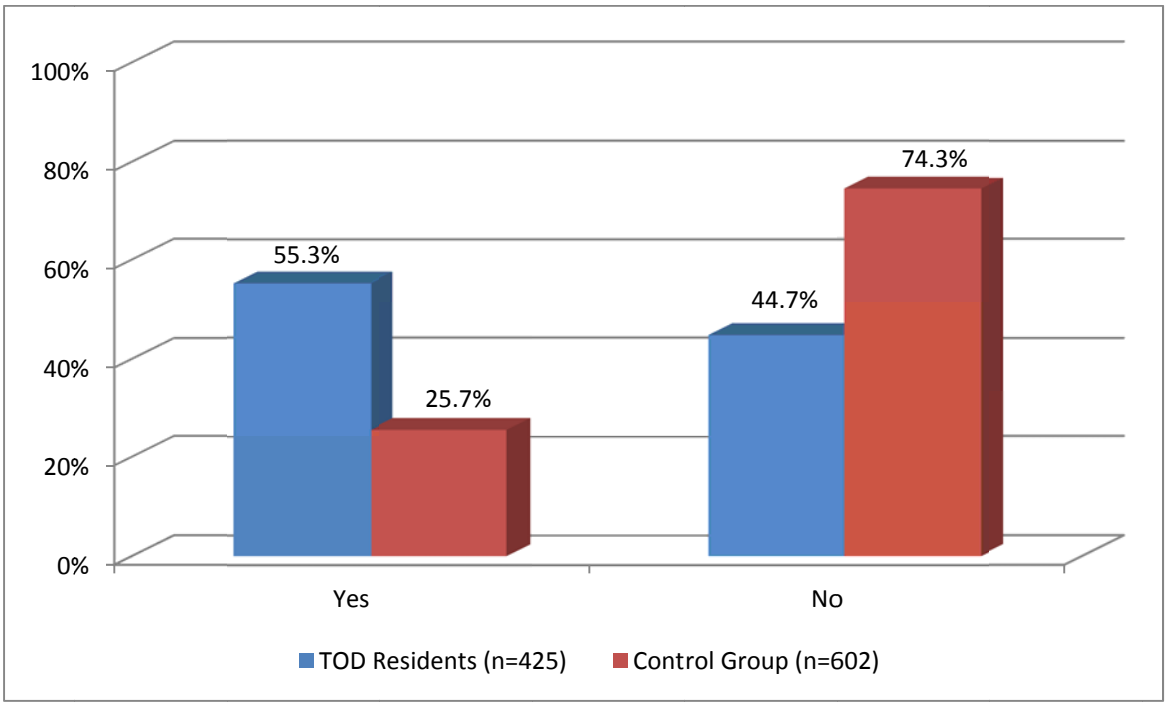

Figure 22. Survey Respondents Who Used Bus or Train for Non-Work Purpose in Past 12 Months.
Note: p < .001

- Respondents were asked whether they used the bus or train for non-work purposes in the past 12 months.
- As shown in Figure 22, 55.3 percent of TOD residents and 25.7 percent of control group respondents indicated "yes."
- Of the respondents who indicated that they use the bus or rail for non-work purposes, TOD residents from the DART area were most likely to use it for other travel (66.7 percent).

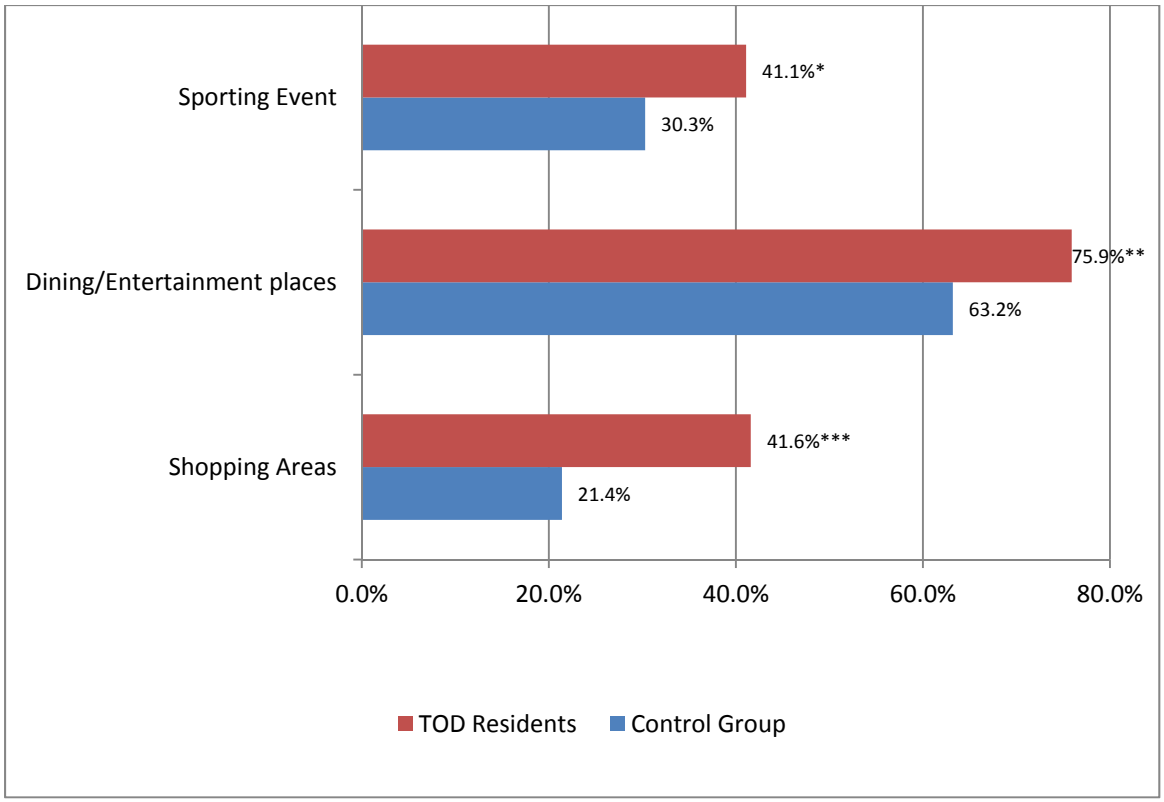

Figure 23. Survey Respondents Who Used Bus or Train to Get to Sporting Events, Entertainment, or Shopping. *Note: The number of respondents for TOD residents and control group respondents is: Sporting Events 236, 155; Dining/Entertainment 237, 155; Shopping Areas 238, 154. * p < .05, ** p < .01, *** p < .001*

- Respondents who reported using the bus or train for non-work purposes in the past 12 months (55.3 percent of TOD residents and 25.7 percent of control group respondents) were asked about the kinds of non-work purposes for which they used the bus.
- As shown in Figure 23, 41.1 percent of TOD residents and 30.3 percent of control group respondents reported using the bus or train for sporting events.
- Seventy-six percent of TOD residents and 63.2 percent of control group respondents reported using the bus or train to reach dining/entertainment places.
- Forty-two percent of TOD residents and 21.4 percent of control group respondents reported using the bus or train for shopping areas.

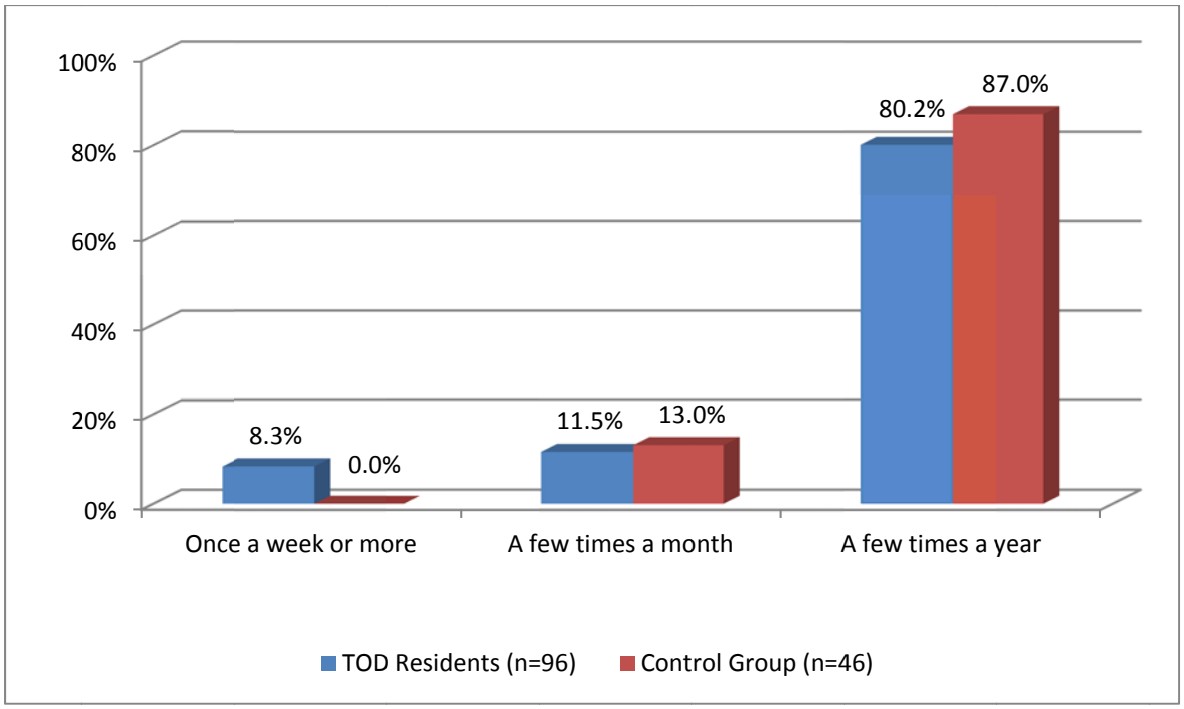

Figure 24. How Often Survey Respondents Used Bus or Train to Get to Sporting Events.

- Respondents who reported using the bus or train to get to sporting events (41.1 percent of TOD residents and 30.3 percent of control group respondents) were asked how often they used the bus for this purpose.
- As shown in Figure 24, the majority of both TOD residents (80.2 percent) and control group respondents (87.0 percent) indicated using the bus a few times a year for sporting events.

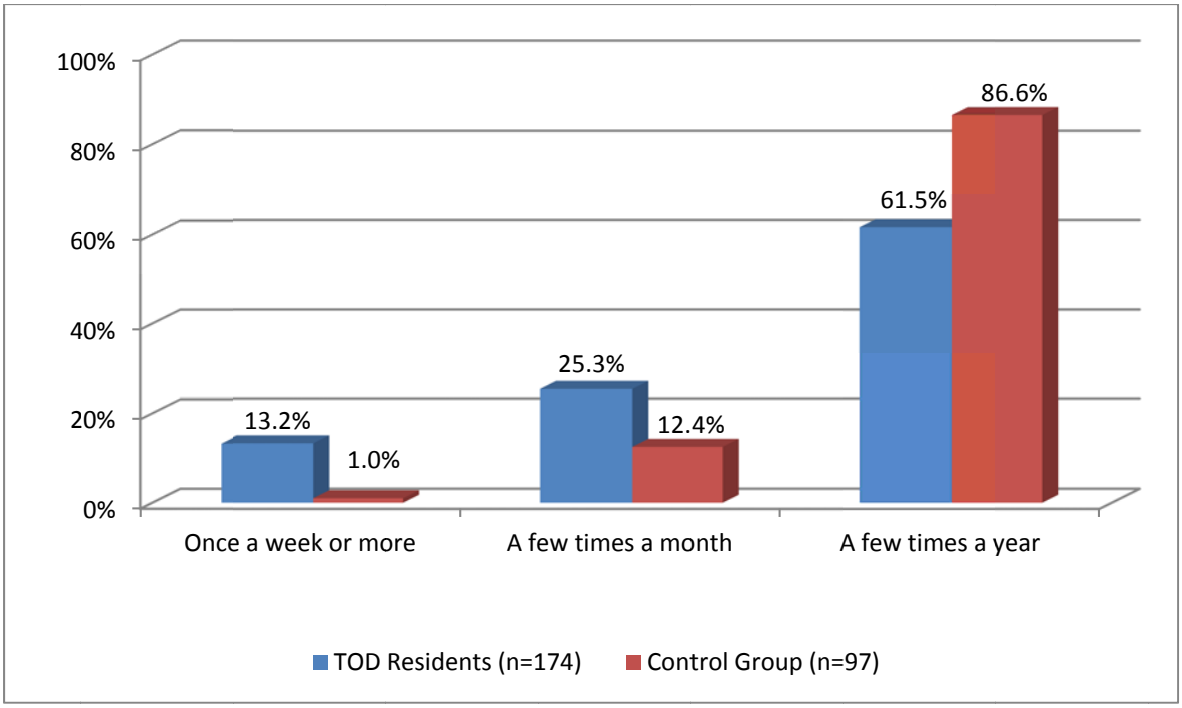

Figure 25. How Often Survey Respondents Used Bus or Train to Get to Dining/Entertainment.

- Respondents who reported using the bus or train to get to dining/entertainment (75.9 percent of TOD residents and 63.2 percent of control group respondents) were asked how often they used the bus for this purpose.
- Figure 25 shows that the majority of both TOD residents (61.5 percent) and control group respondents (86.6 percent) used the bus or train to get to dining/entertainment a few times a year.
- In contrast, the TOD residents used a bus or train to get to dining/entertainment more often (once a week or more 13.2 percent and a few times a month 25.3 percent) than control group respondents.
- As shown in Table 7, Austin residents rode the bus or train more frequently than residents in other areas.

Table 7. How Often Survey Respondents Used Bus or Rail to Get to Dining/Entertainment Places

	Percentage Responding		
	DART (n=71)	Fort Worth (n=54)	Austin (n=49)
Once a week or more	5.6%	14.8%	22.4%
A few times a month	18.3%	16.7%	44.9%
A few times a year	76.1%	68.5%	32.7%

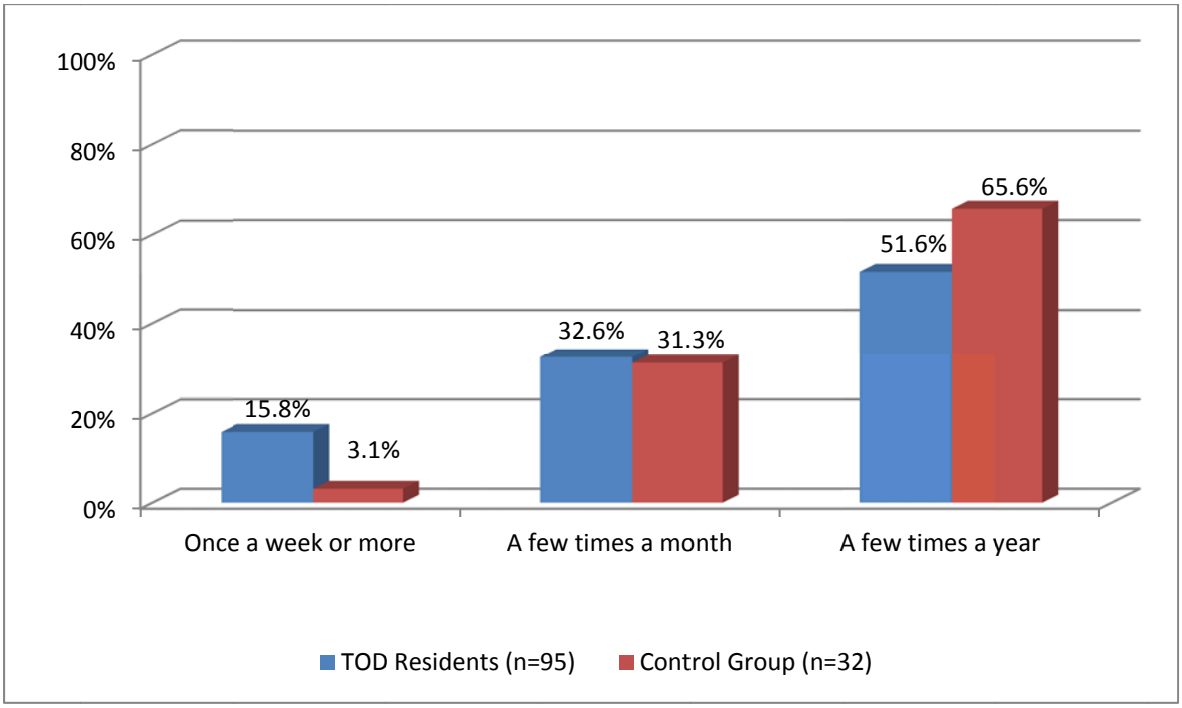

Figure 26. How Often Survey Respondents Used Bus or Train to Get to Shopping Areas.

- Respondents who reported using the bus or train to get to shopping areas (41.6 percent of TOD residents and 21.4 percent of control group respondents) were asked how often they used the bus for this purpose.
- As shown in Figure 26, the majority of both the TOD residents (51.6 percent) and control group respondents (65.6 percent) used the bus or train to get to shopping areas a few times a year.
- Among those who had used a bus or train to get to shopping areas, 21.7 percent of Austin residents, 24.2 percent of Fort Worth residents, and 5.1 percent of DART area residents said they use these methods once a week or more to get to shopping areas (see Table 8).

Table 8. How Often Survey Respondents Used Bus or Rail to Get to Shopping Areas

	Percentage Responding		
	DART (n=39)	Fort Worth (n=33)	Austin (n=23)
Once a week or more	5.1%	24.2%	21.7%
A few times a month	30.8%	21.2%	52.2%
A few times a year	64.1%	54.5%	26.1%

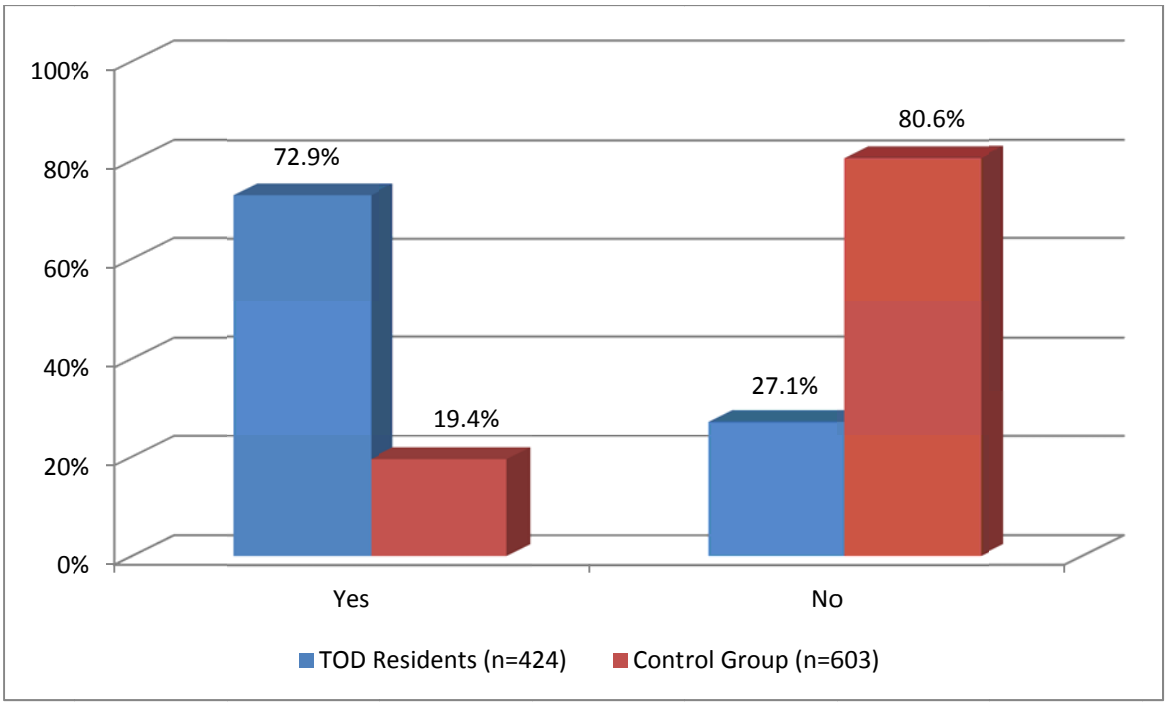

Figure 27. Survey Respondents Who Walked to Entertainment, Dining, or Shopping in the Past 3 Months. *Note: $p < .001$*

- Respondents were asked if they had walked to get to entertainment, dining, or shopping in the past 3 months. As shown in Figure 27, 72.9 percent of TOD residents and 19.4 percent of control group respondents indicated "yes."

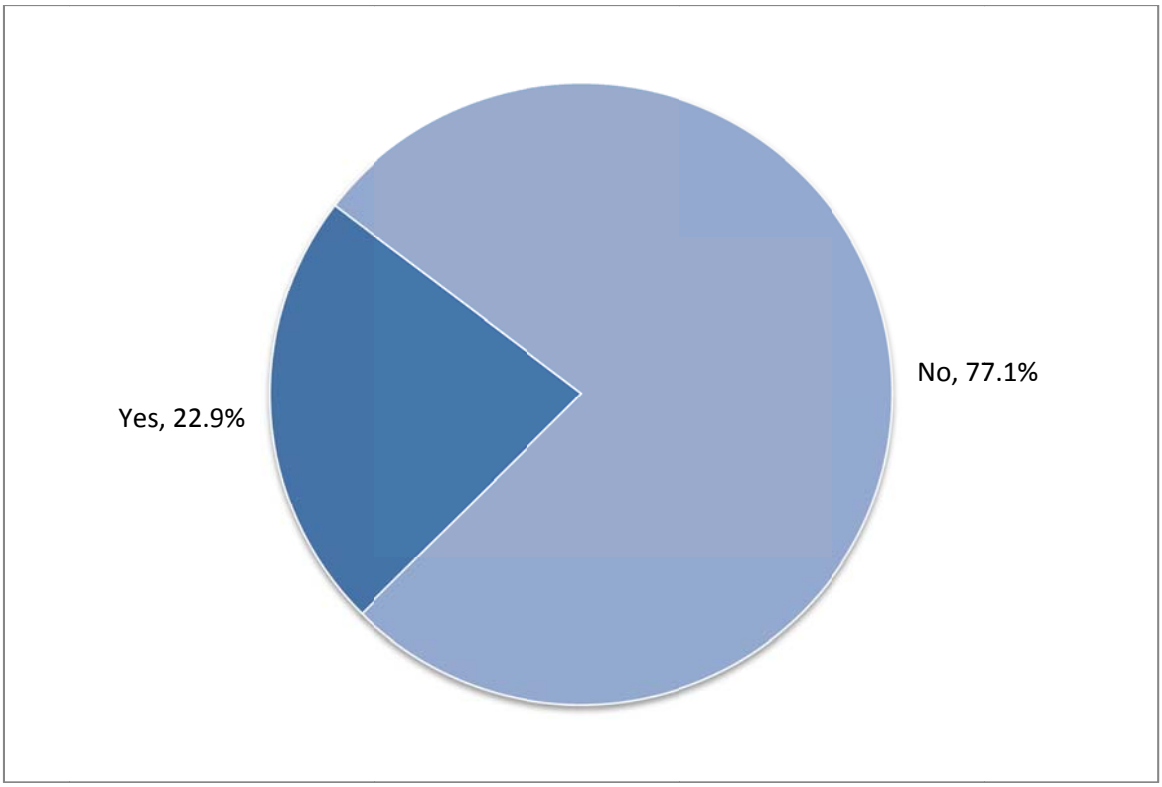

Figure 28. TOD Residents with Previous Home within a 10 Minute Walking Distance of a Train Station.
Note: Only TOD residents were asked this question.

- TOD residents were asked if their last home was within a 10 minute walking distance or 1/4 mile of a train station. As shown in Figure 28, 22.9 percent indicated “yes.”

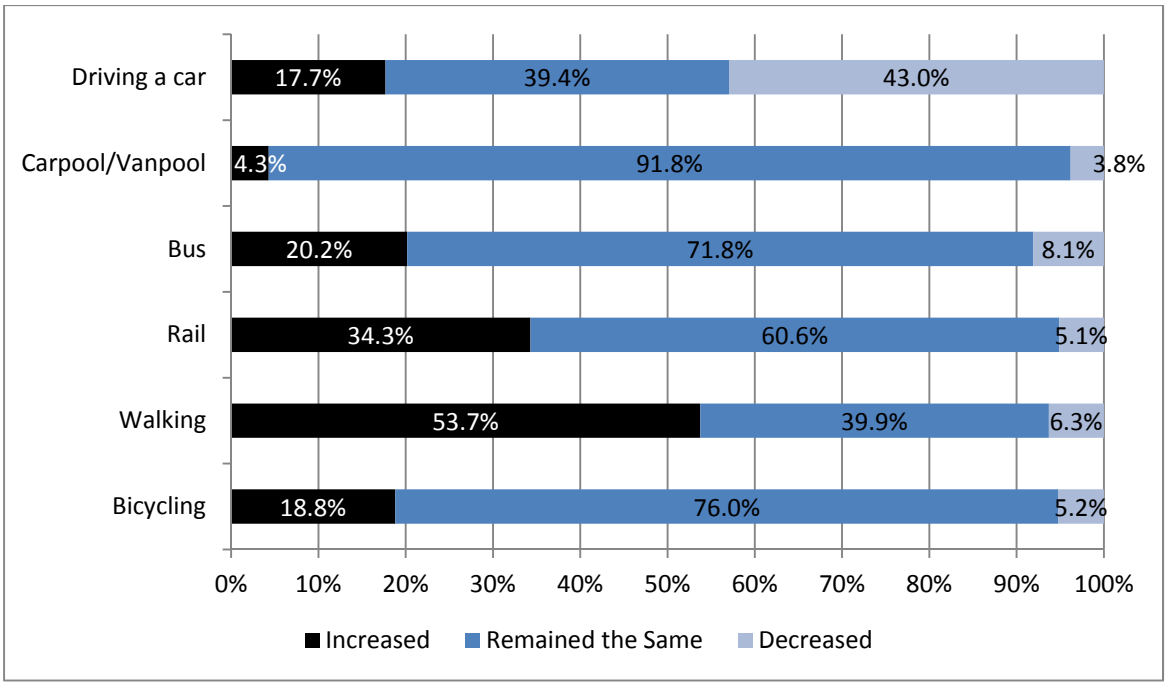

Figure 29. Overall Change of Use of Types of Transportation since Moving to Current Residence. *Note: Only TOD residents were asked these questions; the number of residents who responded is: Driving Car 419; Car/Vanpool 368; Bus 372; Train 376; Walked 378; Bicycled 367.*

- TOD resident respondents were asked if their use of the different types of transportation listed above increased, decreased, or generally remained the same since moving to their current residence.
- As shown in Figure 29, 53.7 percent indicated that walking increased since moving to their current residence.
- Thirty-four percent increased their rail usage and 20.2 percent increased their bus usage. Among the residents whose use of the bus increased, respondents from Austin showed the highest increase in use (33.9 percent).
- Ninety-two percent indicated that use of carpool/vanpool remained the same since moving to their current residence.
- Forty-three percent indicated that car usage decreased since moving to their current residence.
- Table 9 shows that among the residents whose use of the rail increased, respondents from the DART area showed the highest increase in use (49.6 percent).
- Fort Worth residents showed a 44.2 percent increase in use of the rail while Austin showed only an 8.8 percent increase in use.

Table 9. Survey Respondents' Use of Rail after Move to Current Residence			
	Percentage Responding		
	DART (n=123)	Fort Worth (n=129)	Austin (n=125)
Increased	49.6%	44.2%	8.8%
Remained the Same	48.0%	51.2%	83.2%
Decreased	2.4%	4.7%	8.0%

- According to Table 10, among the residents who reported that their walking had increased, respondents from the DART area showed the highest increase (61.8 percent).
- Austin residents showed a 57.8 percent increase while Fort Worth showed a 41.4 percent increase in walking.

Table 10. Survey Respondents' Walking Behavior after Move to Current Residence			
	Percentage Responding		
	DART (n=123)	Fort Worth (n=128)	Austin (n=128)
Increased	61.8%	41.4%	57.8%
Remained the Same	34.1%	55.5%	29.7%
Decreased	4.1%	3.1%	12.5%

- Table 11 shows that among the residents who reported an increase in bicycling, respondents from Austin showed the highest increase (28.0 percent).
- Residents from the DART area showed a 17.2 percent increase while residents from Fort Worth showed only a 10.7 percent increase in bicycling.

Table 11. Survey Respondents' Bicycling after Move to Current Residence			
	Percentage Responding		
	DART (n=122)	Fort Worth (n=121)	Austin (n=125)
Increased	17.2%	10.7%	28.0%
Remained the Same	81.1%	81.8%	65.6%
Decreased	1.6%	7.4%	6.4%

Lifestyle and Transportation Experiences

Table 12. Lifestyle and Transportation Factors in Choosing Current Residence

	Average Score (1-5)	Percentage Responding				
		Not Important 1	Of Little Importance 2	Moderately Important 3	Important 4	Very Important 5
Closer to work (n=405)	3.74	11.6%	7.7%	16.0%	24.4%	40.2%
Urban Lifestyle (n=413)	3.54	10.2%	13.1%	21.3%	23.5%	32.0%
Parking availability (n=415)	3.44	11.8%	10.8%	23.4%	29.4%	24.6%
Close to Restaurants. (n=411)	3.33	12.7%	13.4%	25.5%	25.5%	22.9%
Close to Various Forms of Entertainment (n=409)	3.31	12.5%	13.7%	25.9%	26.7%	21.3%
Availability of shopping (n=413)	3.02	13.1%	19.4%	32.0%	23.5%	12.1%
Close to a train station (n=419)	2.93	21.7%	20.8%	21.0%	16.0%	20.5%
Close to a bus stop (n=414)	2.49	33.3%	25.4%	15.9%	9.9%	15.5%

- TOD resident respondents were asked to rate factors as "not important, of little importance, moderately important, important, or very important" in the respondent's choice to purchase or rent their current residence (see Table 12).
- The reasons with the highest average importance score were closer to work, urban lifestyle, and parking availability.
- Close to a train station was very important or important to 36.5 percent of the TOD residents, while 42.5 percent reported that this factor was of little or not important for their choice of residence. Close to a bus stop was very important or important to 25.4 percent of the TOD residents, with 58.7 assigning little or no importance to this factor.

Differences among Service Areas

- Residents from the DART area reported an average importance rating of 4.05 for "urban lifestyle," while Austin residents reported a 3.65 and Fort Worth residents a 2.99.
- Residents from the DART area reported an average importance rating of 3.76 for "close to restaurants," while Austin residents reported a 3.41 and Fort Worth residents a 2.88.

- Residents from Fort Worth reported an average importance rating of 3.27 for "close to a train station," while DART area residents reported a 3.16 and Austin residents a 2.29.
- Residents from Austin reported an average importance rating of 3.06 for "close to a bus stop," while Fort Worth residents reported a 2.42 and DART area residents a 2.00.
- Residents from the DART area reported an average importance rating of 3.57 for "close to various forms of entertainment," while Austin residents reported a 3.47 and Fort Worth residents a 2.93.
- Residents from Fort Worth reported an average importance rating of 4.03 for "closer to work," while DART area residents reported a 3.59 and Austin residents a 3.55.

Perceptions of Transit Rail Services

Table 13. Level of Agreement with Statements about Transportation

	Average Score (1-5)	Percentage Responding				
		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
During rush hour, I believe taking the train to would be faster than driving. (n=424)	3.89	3.3%	6.8%	20.8%	35.8%	33.3%
I know how to use the rail system. (n=421)	3.55	9.3%	15.7%	12.8%	35.6%	26.6%
The train offers high-quality transit service. (n=141)	3.55	2.4%	4.6%	44.2%	33.6%	15.2%
The train provides a safe environment for my travel. (n=421)	3.54	2.6%	4.5%	43.0%	36.3%	13.5%
The routes I drive to the places I go are usually congested. (n=418)	3.40	3.1%	19.6%	25.1%	38.3%	13.9%
The train schedules are convenient to my needs. (n=419)	2.93	11.2%	18.6%	42.5%	21.0%	6.7%
The train system goes to most of the locations I need to go. (n=417)	2.41	26.9%	29.3%	25.2%	13.4%	5.3%

- TOD resident respondents were asked to rate their level of agreement with the statements shown in descending order of agreement in Table 13.
- Sixty-nine percent of respondents agreed (35.8 percent) or strongly agreed (33.3 percent) that during rush hour, they believe taking the train to downtown would be faster than driving.
- Sixty-two percent of respondents agreed (35.6 percent) or strongly agreed (26.6 percent) that they know how to use the train system.

- Forty-nine percent of respondents agreed (33.6 percent) or strongly agreed (15.2 percent) that the train offers high-quality transit service.
- Fifty percent of respondents agreed (36.3 percent) or strongly agreed (13.5 percent) that the train provides a safe environment for their travel.
- Fifty-two percent of respondents agreed (38.3 percent) or strongly agreed (13.9 percent) that the routes they drive to the places they go are usually congested.
- About 28 percent of respondents agreed or strongly agreed that train schedules are convenient to their needs with a similar percentage (29.8 percent) disagreeing or strongly disagreeing.
- Less than 20 percent of respondents (18.7 percent) agreed or strongly agreed that the train system goes to most of the locations they need to go. Over 56 percent indicate that the transit rail system does not go to most of the places they need to go.

Differences among Service Areas

- Respondents from the DART area and Fort Worth showed an average agreement rating of 3.75 for "I know how to use the rail," while Austin residents showed a 3.09.
- Respondents from the DART area showed an average agreement rating of 2.78 for "the rail goes to the locations I need," while Fort Worth residents showed a 2.66 and Austin residents a 1.75.
- Respondents from Fort Worth showed an average agreement rating of 3.81 for "the rail provides a safe environment," while Austin residents showed a 3.43 and DART area residents a 3.32.
- Respondents from Fort Worth showed an average agreement rating of 3.85 for "the rail offers high quality service," while DART area residents showed a 3.47 and Austin residents a 3.25.
- Respondents from the DART area showed an average agreement rating of 3.43 for "rail schedules are convenient for my needs," while Fort Worth residents showed a 3.06 and Austin residents a 2.30.
- Respondents from Fort Worth showed an average agreement rating of 4.18 for "during rush hour, taking the rail downtown is faster than driving," while DART area residents showed a 3.89 and Austin residents a 3.54.

VI. IMPACTS OF TRANSIT-ORIENTED DEVELOPMENT ON TEXAS DEPARTMENT OF TRANSPORTATION FACILITY USE AND REVENUES

Utilizing the data and information gathered in previous tasks, we estimate the impacts of changes in TOD resident travel behavior on vehicle miles traveled (VMT) and the impacts on TxDOT revenues based on motor fuel taxes. We have assessed these impacts for current conditions (existing developments) and for two future scenarios assuming growth in the number of TOD residential units in the state.

Forty-three percent of survey respondents reported traveling fewer miles on both highways and other roads after moving into a TOD property. The average reduction in highway miles driven each week per resident is 30.9 while the average reduction in other miles is 8.8 for a total of 39.7 miles per week less driving. Based on previous TOD studies, we assumed that each household has an average of 1.7 residents and that all residents exhibit the same travel behavior, on average. Multiplying the number of residents per household times the reduction in miles driven times 52 weeks per year yields a total annual reduction per household of 3,505.6, of which 2,728.8 are highway miles and 776.9 are non-highway miles (see Table 14).

The lion's share of TxDOT revenues is based on fuel taxes and therefore on the total number of gallons of fuel sold. Using the current Corporate Average Fuel Efficiency (CAFE) standard of 28.8 miles per gallon,[2] the reduction in total miles traveled reduces household fuel consumption by 121.7 gallons annually. State and federal motor fuel taxes are assessed on a per-gallon-sold basis. Figure 30 shows the current allocation of state motor fuel taxes by rate of taxation per gallon. At current tax rates, direct state motor fuel taxes that go to TxDOT are reduced by about $9.13 per TOD household per year (see Table 14). The federal motor fuel tax rate is 18.4 cents per gallon, of which about 12.9 cents per gallon is remitted to Texas (see Figure 31). At this rate of taxation, each TOD household reduces federal motor fuel tax remittances to the state by about $15.70 per year. In total, the average annual reduction in state and federal motor fuel tax revenues attributable to TOD household changing their travel behavior is about $24.83 per household per year.

[2] CAFE standard provided by the National Highway Traffic Safety Administration (NHTSA).

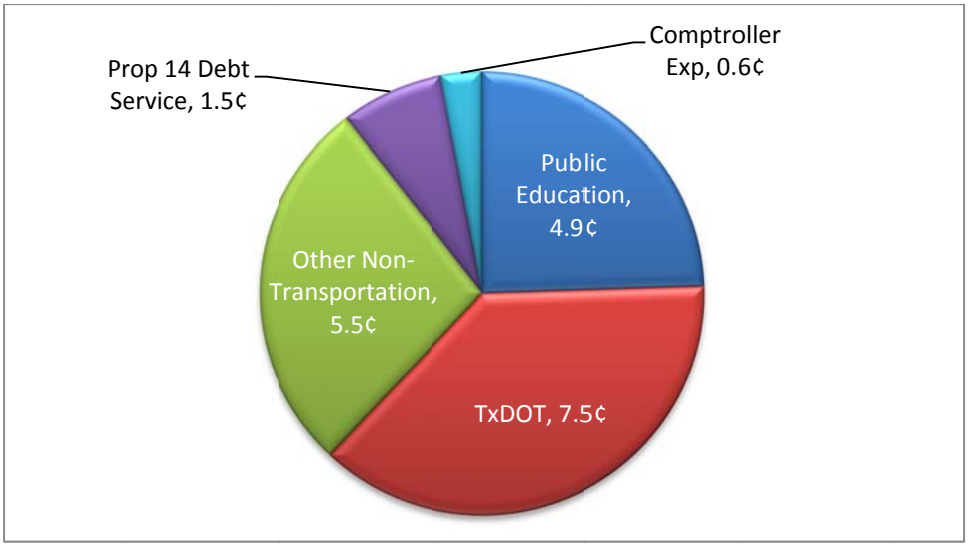

Figure 30. Allocation of Texas Fuel Tax (per gallon). *Note: Based on state fuel tax rate of 20¢ per gallon. Source: TxDOT*

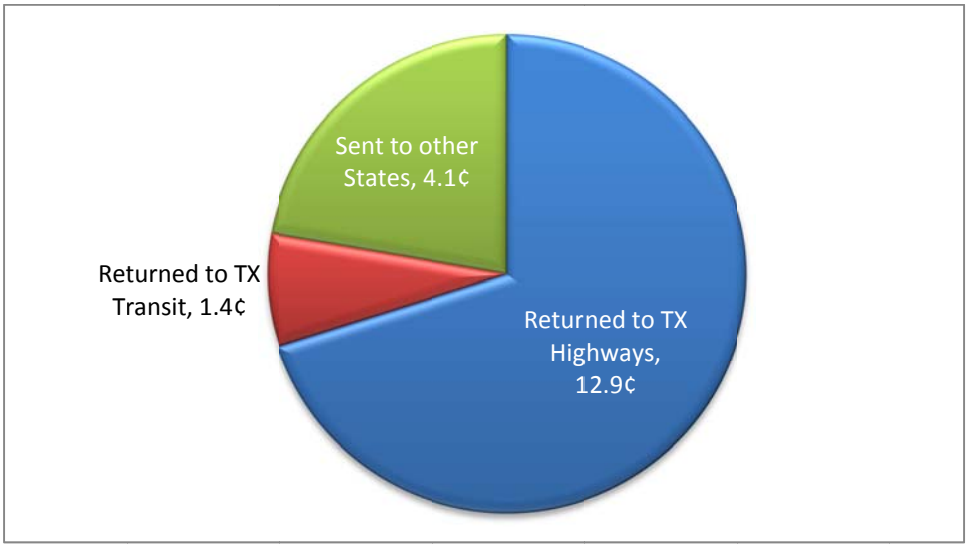

Figure 31. Allocation of Federal Fuel Tax (per gallon). *Note: Based on federal fuel tax rate of 18.4¢ per gallon. Source: TxDOT*

Table 14. Impact of Transit-Oriented Development: All Systems (per household, n=211)

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-2,728.8	-776.9	-3,505.6
Number of Gallons of Fuel	-94.7	-27.0	-121.7
Revenue (State of Texas)	-$7.11	-$2.02	-$9.13
Federal Fuel Tax Remittances	-$12.22	-$3.48	-$15.70
Total Impact on Revenue	-$19.33	-$5.50	-$24.83

Source: University of North Texas, Texas Department of Transportation, NHTSA

In addition, our analysis examines the impact and the effect TOD has on the driving habits of individual households in each TOD area. The data show that there is no single "type" of TOD resident or development in Texas; distinct regional differences emerge in roadway usage, type of miles, preferred modes of travel, and resident characteristics. Many factors may affect the driving, commuting, and public transportation usage in each area. These include:

- Historic development patterns.
- Attitudes toward public transportation.
- Age and scale of the system.
- Success of various regional marketing efforts.
- Existing roadways.
- Location of work and entertainment centers.
- Urban and suburban bias.
- The demographics and occupations of the TOD residents in that area.

Understanding these nuances among the regions and the role of TOD will prove essential in the creation of policy and the examination of additional TxDOT revenue streams in the future.

Households living in a DART TOD reported an annual reduction of 4,939.7 VMT, while TxDOT revenues decline by $34.99 per household, representing the greatest change of the three regions (see Tables 15 and 18). This may be attributed to accessibility and penetration of DART into the suburbs, compared to the other rail systems in the state. DART is also the oldest transit rail system in our study group; it is possible that TOD residents in Dallas and the surrounding counties are more familiar and comfortable with DART. While households in Fort Worth report a less significant reduction of 4,168 VMT since relocating to a TOD (see Table 16), a striking difference between the two regions is the number of non-highway miles. In the DART area, 24 percent of VMT are considered non-highway. In Fort Worth non-highway miles account for 6 percent of VMT, an 18 percent difference. This difference is attributable, in part, to the number of DART stations that are located on arterial roadways. Austin residents report the lowest reduction of VMT since moving into a TOD, 1,442 per household (see table 17). One possible factor affecting the VMT in Austin is that it is the newest addition to the state's light

right network. Austin also has a disproportionate number of college students residing in TOD properties; students may tend to be "local" in their spending and commuting habits.

Table 15. Impact of Transit-Oriented Development: DART (per household, n=66)

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-3,744.7	-1,195.0	-4,939.7
Number of Gallons of Fuel	-130.0	-41.5	-171.5
Revenue (State of Texas)	-$9.75	-$3.11	-$12.86
Federal Fuel Tax Remittances	-$16.77	-$5.35	-$22.13
Total Impact on Revenue	-$26.52	-$8.46	-$34.99

Source: University of North Texas, Texas Department of Transportation, NHTSA

Table 16. Impact of Transit-Oriented Development: TRE (per household, n=75)

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-3,934.4	-234.5	-4,168.9
Number of Gallons of Fuel	-136.6	-8.1	-144.8
Revenue (State of Texas)	-$10.25	-$0.61	-$10.86
Federal Fuel Tax Remittances	-$17.62	-$1.05	-$18.67
Total Impact on Revenue	-$27.87	-$1.66	-$29.53

Source: University of North Texas, Texas Department of Transportation, NHTSA

Table 17. Impact of Transit-Oriented Development: Capital Metro (per household, n=70)

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-740.3	-702.6	-1,442.8
Number of Gallons of Fuel	-25.7	-24.4	-50.1
Revenue (State of Texas)	-$1.93	-$1.83	-$3.76
Federal Fuel Tax Remittances	-$3.32	-$3.15	-$6.46
Total Impact on Revenue	-$5.24	-$4.98	-$10.22

Source: University of North Texas, Texas Department of Transportation, NHTSA

Table 18. Summary Impact of Transit-Oriented Development (by system, per household, n=211)			
	Austin	DART	Ft. Worth
Vehicle Miles Traveled	-1,442.8	-4,939.7	-4,168.9
Number of Gallons of Fuel	-50.1	-171.5	-144.8
Revenue (State of Texas)	-$3.76	-$12.86	-$10.86
Federal Fuel Tax Remittances	-$6.46	-$22.13	-$18.67
Total Impact on Revenue	-$10.22	-$34.99	-$29.53

Source: University of North Texas, Texas Department of Transportation, NHTSA

Comparing the VMT after a household relocates to a TOD to the average household in the area is another method of examining the changes in VMT by region. DART TOD residents reduce their VMT by 21.5 percent (see table 19). Austin reports the least change at 6.5 percent. The average change in VMT for TOD residents is 15.1 percent.

Table 19. Transit-Oriented Development Impact on Vehicle Miles Traveled (per household)			
	VMT per Household	Change VMT	% Change
DART	22,998.9	-4,939.7	-21.5%
Fort Worth	24,112.5	-4,168.9	-17.3%
Austin	22,297.5	-1,442.8	-6.5%
Weighted Average	23,193.9	-3,505.6	-15.1%

Source: University of North Texas, Texas Department of Transportation, NHTSA, Center for Neighborhood Technology

Our inventory of TOD projects identified 8,945 residential units currently in Texas. If we assume an average occupancy rate of 90 percent for these properties, there are 8,051 occupied TOD households currently in the state. Table 20 presents the impacts of changes in travel behavior by current TOD residents on vehicle miles traveled and motor fuel tax revenues allocated to TxDOT. For example, using our estimated reduction in annual highway miles driven of 3,505.6 miles per household and multiplying this estimate by 8,051 household, yields a total reduction in state highway miles traveled by 21.9 million miles per year. When combined with the reduction in non-highway miles at about 6.2 million VMT, residents of TOD lowered total state VMT by 28.2 million miles. The total impact on TxDOT revenues is a nearly $200,000 per

year, which is a very small percentage of total revenues. Tables 21, 22, and 23 provide the economic impact for each TOD region.

Table 20. Impact of Existing Transit-Oriented Development: DART, TRE, Capital Metro (8,051 currently occupied residential units)

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-21,967,975.9	-6,254,081.9	-28,222,057.7
Number of Gallons of Fuel	-767,776.9	-217,155.6	-979,932.6
Revenue (State of Texas)	-$57,208.3	-$16,286.7	-$73,494.9
Federal Fuel Tax Remittances	-$98,398.2	-$28,013.1	-$126,411.3
Total Impact on Revenue	-$155,606.5	-$44,299.7	-$199,906.2

Source: University of North Texas, Texas Department of Transportation, NHTSA

Table 21. Impact of Existing Transit-Oriented Development: DART (4,909 currently occupied residential units)

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-18,381,158.7	-5,865,790.8	-24,246,949.5
Number of Gallons of Fuel	-638,234.7	-203,673.3	-841,908.0
Revenue (State of Texas)	-$47,871.5	-$15,276.7	-$63,148.2
Federal Fuel Tax Remittances	-$82,339.0	-$26,276.0	-$108,615.0
Total Impact on Revenue	-$130,210.5	-$41,552.7	-$171,763.2

Source: University of North Texas, Texas Department of Transportation, NHTSA

Table 22. Impact of Existing Transit-Oriented Development: Ft. Worth (2,023 currently occupied residential units)

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-7,959,380.5	-474,393.2	-8,433,773.7
Number of Gallons of Fuel	-276,367.4	-16,472.0	-292,839.4
Revenue (State of Texas)	-$20,727.6	-$1,235.4	-$21,963.0
Federal Fuel Tax Remittances	-$35,651.4	-$2,124.9	-$37,776.3
Total Impact on Revenue	-$56,378.9	-$3,360.3	-$59,739.2

Source: University of North Texas, Texas Department of Transportation, NHTSA

Table 23. Impact of Existing Transit-Oriented Development: Austin (1,119 currently occupied residential units)

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-828,350.0	-786,157.9	-1,614,507.9
Number of Gallons of Fuel	-28,762.2	-27,297.1	-56,059.3
Revenue (State of Texas)	-$2,157.2	-$2,047.3	-$4,202.4
Federal Fuel Tax Remittances	-$3,710.3	-$3,521.3	-$7,231.7
Total Impact on Revenue	-$5,867.5	-$5,568.6	-$11,436.1

Source: University of North Texas, Texas Department of Transportation, NHTSA

Potential Future Impacts

Transit-oriented development has gained a foothold in Texas and the rest of the nation. Nearly every major city in the United States is incorporating new urbanism and TOD in their planning and zoning processes. While TOD is often considered elements of lifestyle choices for Gen X or Gen Y, baby boomers are helping to drive TOD and new urbanism. As baby boomers become empty nesters, many of the features of TOD become increasingly attractive—living space that encourages downsizing while being located in close proximity to healthcare, amenities, and entertainment options. The result will be increasing demand for TOD. Houston Metro purports that by 2030 there will be demand for 166,000 TOD residential units in their service area. To provide additional scale to our estimates, we present future impacts under two scenarios: Scenario 1 is based on 20,000 TOD households (Table 24), and Scenario 2 is based on 100,000 TOD households (Table 25) statewide.

As noted in our inventory of TOD projects, developments that are in the conceptual and planning phases, if realized, would add well over 12,000 new TOD residences. Therefore, we offer the 20,000 unit scenario as a representation of the future market based on current plans. At this level of development, the total reduction in annual VMT in the state would increase to about 121 million miles per year consequentially reducing TxDOT revenues by about $496,000 each year (see Table 24).

Table 24. Impact of Future Transit-Oriented Development
Scenario 1: 20,000 TOD Households

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-54,575,432.2	-15,537,126.5	-70,112,558.8
Number of Gallons of Fuel	-1,894,980.3	-539,483.6	-2,434,463.8
Revenue (State of Texas)	-$142,123.5	-$40,461.3	-$182,584.8
Federal Fuel Tax Remittances	-$244,452.5	-$69,593.4	-$314,045.8
Total Impact on Revenue	-$386,576.0	-$110,054.6	-$496,630.6

Source: University of North Texas, Texas Department of Transportation, NHTSA

Over a more extended time period, there could be 100,000 TOD residential units in the state, which would result in lowering total VMT by more than 350 million and reducing TxDOT revenues by $2.4 million (see Table 25). These estimates are based on current tax rates and current CAFE standards. Increasing the motor fuel tax rate would exacerbate the reduction in

TxDOT revenues, while likely increases in average vehicle fuel efficiencies would lower the impacts on revenues.

Table 25. Impact of Future Transit-Oriented Development Scenario 2: 100,000 TOD Households

	Highway	Non-Highway	Total
Vehicle Miles Traveled	-272,877,161.1	-77,685,632.7	-350,562,793.9
Number of Gallons of Fuel	-9,474,901.4	-2,697,417.8	-12,172,319.2
Revenue (State of Texas)	-$710,617.6	-$202,306.3	-$912,923.9
Federal Fuel Tax Remittances	-$1,222,262.3	-$347,966.9	-$1,570,229.2
Total Impact on Revenue	-$1,932,879.9	-$550,273.2	-$2,483,153.1

Source: University of North Texas, Texas Department of Transportation, NHTSA

Moving to TOD residential units is associated with substantial changes in household VMT with consequential impacts on TxDOT revenues. While these changes represent a relative blip based on the total number of current units, the increasing use of this type of development and the emphasis on new urbanism in the state's major metropolitan areas clearly suggests that the impacts of changing travel behavior for new TOD residents will expand. These findings clearly point to the need for TxDOT and other transportation planners to recognize the impacts of TOD residents on facility demand and presents a new challenge for policy makers in developing fiscally sustainable sources of transportation infrastructure funding.

VII. IDENTIFICATION OF STATE GOVERNMENT/DEPARTMENTS OF TRANSPORTATION ROLES IN ENCOURAGING TRANSIT-ORIENTED DEVELOPMENT

As funding for additional transportation capacity continues to shrink, emphasis on maximizing the benefits of existing infrastructure investments has increased. Recent federal initiatives have focused on leveraging land use and transportation investments (and particularly transit investments) to help develop sustainable communities and achieve environmental benefits. Laws and regulations have come into effect that require municipalities to put programs into place that will reduce vehicle miles traveled and CO_2 emissions.

Transit-oriented developments have come into the spotlight as part of the movement toward sustainable transportation. A TOD reduces automobile reliance by combining mixed-use development with a transit element that creates efficiency and allows people to walk, bike, or use transit for daily trips.

Figure 32. A Before Photo and After Rendering of Vandergriff Drive in Carrollton, TX, for the City's TOD Catalyst Project (Source: City of Carrollton).

State Departments of Transportation (DOTs) are taking an increased role in the development of TODs. State DOTs have historically not been involved in the TOD process; however, Federal Transit Administration (FTA) funding can be obtained in order to facilitate more active State DOT involvement. The FTA suggests the following TOD-related activities that can be funded by FTA grants (FTA "Transit"):

- Real estate acquisition.
- Demolition.
- Site preparation.

- Building foundations.
- Utilities.
- Walkways.
- Open space.
- Safety and security equipment and facilities.
- Facilities that incorporate community services like healthcare and daycare.
- Intermodal transfer facilities.
- Transportation-related furniture, fixtures, and equipment.
- Parking.
- Project development activities.
- Professional services.
- Pedestrian improvements.
- Bicycle improvements.

The purpose of this section is to identify the variety of ways state DOTs are involved in supporting TOD. This section provides both an overview of state DOT roles in TOD and case studies that highlight key states that have actively supported TOD.

Preliminary Review: Researching Department of Transportation Websites for Transit-Oriented Development

Researchers searched all 50 state DOT websites, as well as the District of Columbia and United States DOT websites, for TOD information. Upon reaching the homepage, researchers searched primarily for links to transit or planning departments. Some DOT websites have transit divided into bus, rail, and occasionally additional modes; in those instances, researchers reviewed all mode sections.

For the state DOTs that did not have a webpage dedicated to TOD, researchers used the "search" function on the website using the term "transit-oriented development." In most instances, this tactic succeeded in locating TOD information. This information generally referred to specific TOD projects or project proposals. Table 26 shows the initial findings for TOD involvement in state DOTs, the District of Columbia DOT, and the federal DOT.

Table 26. Federal/State DOT Transit-Oriented Development Involvement	
DOT	**Information**
U.S. DOT	FTA and Department of Housing and Urban Development (HUD) are working together to address barriers to transit-oriented development at the local and regional level. Jointly, FTA and HUD have developed an action guide to help planners implement mixed-income transit-oriented development and regional transit corridor planning. Also, FTA has been working with the Center for Transit Oriented Development and HUD to develop an online database that includes information on land available for development near over 4,000 existing and planned rail/transit stations. Additionally, FTA has a partnership with HUD and the Environmental Protection Agency (EPA) joined the FTA and HUD in their efforts and created the Partnership for Sustainable Communities (PSC). This new partnership focuses on improving access to affordable housing, providing more transportation options, lowering transportation costs and protecting the environment nationwide.
Alabama	None.
Alaska	None.
Arizona	None.
Arkansas	None.
California	California has enacted legislation to improve the environment by reducing tailpipe emissions. California believes TOD can be part of the solution to achieving these goals.
Colorado	Projects proposed on website.
Connecticut	Projects proposed on website.
Delaware	None.
District of Columbia	Transit-oriented development in the District of Columbia is a land use strategy to accommodate new growth, strengthen neighborhoods, and expand choices and opportunities by capitalizing on bus and rail assets to stimulate and support vibrant, compact, diverse, and accessible neighborhood centers within an easy walk of transit.
Florida	FDOT, in partnership with the Florida Department of Community Affairs, is developing Transit Oriented Development Design Guidelines to promote and implement “transit ready” development patterns in Florida.
Georgia	None.
Hawaii	None.
Idaho	None.
Indiana	None.
Illinois	Illinois Tomorrow Corridor Planning Fund from 2005.
Iowa	None.
Kansas	None.
Kentucky	None.
Louisiana	None.
Maine	None.
Maryland	Maryland is promoting transit-oriented development to increase the number of transit riders and get a better return on this public investment.
Massachusetts	None.

Table 26. Federal/State DOT Transit-Oriented Development Involvement	
DOT	**Information**
Michigan	None.
Minnesota	None.
Mississippi	None.
Missouri	Projects proposed on website.
Montana	None.
Nebraska	None.
Nevada	None.
New Hampshire	None.
New Jersey	NJDOT and NJ TRANSIT spearhead a multi-agency Smart Growth partnership known as the Transit Village Initiative. Since 1999, NJDOT, NJ TRANSIT, and other State agencies have actively been supporting transit-oriented development through the Transit Village Initiative.
New Mexico	NMDOT previously planned a large TOD project for a government facility but it was cancelled due to political issues and has not been resumed.
New York	Projects proposed on website.
North Carolina	None.
North Dakota	None.
Ohio	Projects proposed on website.
Oklahoma	No projects on the website, but a TIGER project was found in an online search.
Oregon	ODOT assists with local agencies by providing technical assistance for TOD projects.
Pennsylvania	Projects receive funding to plan for transit-oriented development.
Rhode Island	None.
South Carolina	None.
South Dakota	None.
Tennessee	None.
Texas	None.
Utah	None.
Vermont	Vermont Agency of Transportation (VTrans) will support Smart Growth and transit-oriented development as it strives to improve mobility, maintain Vermont's rural character, and avoid suburban sprawl.
Virginia	None.
Washington	The Growth and Transportation Efficiency Center (GTEC) program, which is part of the Commute Trip Reduction (CTR) law, works with businesses, schools, and neighborhoods to find new ways to encourage commuters to ride transit, vanpool, carpool, walk, bike, work from home, and use other commute options besides driving alone.
West Virginia	None.
Wisconsin	None.
Wyoming	None.

Some DOT websites referenced TODs in older documents that were submitted by consultants. These consulting documents often recommended TODs. However, when additional information on TODs was not found on the websites, the state was listed as having no TOD involvement.

Once TOD involvement at the DOT was confirmed, researchers conducted a more in-depth web-based investigation to determine the full extent of TOD activities at the DOT. Additionally, researchers conducted personal interviews via phone and email in order to provide more details regarding the DOT involvement.

Table 27 summarizes the types of TOD-supportive activities identified as a result of the website search and interview process. Subsequent sections provide more details, beginning with the federal DOT involvement with TODs.

Table 27. TOD-Supportive Activities, by State

DOT	Statutory/Regulatory Environment	Research and Information Sharing	Planning Guidance	Funding (P=Planning Only)
U.S. DOT		X	X	X
California	X	X	X	X
District of Columbia			X	
Florida	X	X	X	P
Illinois				P
Maryland	X			X
New Jersey	X			P
Oklahoma				X
Oregon	X		X	P
Pennsylvania				X
Washington	X			X

Federal DOT Involvement

At the federal level, there is not a specific grant program that is designed to support transit-oriented development, but most FTA funding can be used for capital projects that support TOD (FTA "Transit"). The FTA has created a website which provides a list of TOD publications and links for users to access that provide information on ways communities have implemented TODs (FTA "TOD").

The FTA and the Department of Housing and Urban Development (HUD) are working together to address barriers to transit-oriented development at the local and regional level. Jointly, the FTA and HUD have developed an action guide to help planners implement mixed-income transit-oriented development and regional transit corridor planning (U.S. DOT 2009). Additionally, FTA and HUD have been working with the Center for Transit Oriented Development to develop an online database that includes information on land available for development in proximity to over 4,000 existing and planned rail/transit stations. Members of Reconnecting America (Center for Transit-Oriented Development) are eligible to access this database, which also contains information on every transit line and station in the U.S., including demographic and land use information on the 1/2-mile radius around stations (Reconnecting America 2007).

In 2009, the Environmental Protection Agency (EPA) joined the FTA and HUD in their efforts and created the Partnership for Sustainable Communities (PSC). This new partnership focuses on improving access to affordable housing, providing more transportation options, lowering transportation costs, and protecting the environment nationwide. The Partnership for Sustainable Communities established six livability principles that will act as a foundation for interagency coordination (EPA 2010):

1. Provide more transportation choices.
2. Promote equitable, affordable housing.
3. Enhance economic competitiveness.
4. Support existing communities.
5. Coordinate policies and leverage investment.
6. Value communities and neighborhoods.

These principles are helping the agencies work together to break down barriers that local and federal governments encounter when implementing TODs. The PSC realizes that regions around the country will have different resources and needs in urban, rural, suburban, and tribal communities and knows that national policies must be sensitive to these differences.

The PSC was developed to assist the FTA and DOTs with improving livability, which should create and maintain safe, reliable, integrated, and accessible transportation networks.

These networks can provide access to employment and other destinations, while enhancing choices for users of transportation across the U.S. (FTA "Livable").

The three agencies that make up the PSC provide grants for sustainable community projects. Currently the DOT and HUD are offering up to $75 million in funding for sustainable community projects. Thirty-five million dollars in TIGER II (Transportation Investment Generating Economic Recovery) planning grants and $40 million in Sustainable Community Challenge Grants will be awarded by the agencies. The partnership between the DOT and HUD makes the grant process easier on applicants because many projects can meet requirements for both of the grants and by offering them together, the applicants only have to go through one application process.

One way the FTA can play a role in projects is to provide support to local and regional organizations in planning. The FTA can and will provide funding but it is important that communities realize the importance of local match money for these federal grants (FTA and Reconnecting America 2010). There are several FTA programs that provide money to current initiatives that support goals of the PSC

- State of Good Repair Initiative (FTA "State") – A program to ensure existing transit systems provide safe and reliable services to communities by sharing ideas on recapitalization, maintenance issues, asset management practices, and innovative financing strategies.
- New policy direction for the New Starts Program – This broadened the DOT's evaluation criteria used to assess applications for funding to include economic development, environmental issues, and other community-based concerns to promote livability.
- Two new "livability" grant programs – The Urban Circulator Systems Program and the Bus Livability Grants Initiative Program. These two programs will provide up to $280 million in grant money for "livability" focused transit projects. The Urban Circulator System Program provides $130 million from unallocated Discretionary New Starts/Small Starts Program funds. The Bus Livability Grants will provide $150 million in unallocated Discretionary Bus and Bus Facilities Program funds.
- New proposed policy to expand bike/pedestrian catchment areas around transit stops – This will encourage projects that promote walking and biking.
- Sustainable Communities Partnership Brownfield Pilot Projects – FTA will provide technical assistance on five brownfield pilot projects. Brownfields are abandoned or underused industrial and commercial facilities, and the Brownfield Pilot projects

provide planning for assessments, cleanups, and sustainable development of these brownfield sites.

State DOT Involvement in TOD

California

Statutory/Regulatory Environment

The State of California TOD statute provides guidelines for local jurisdictions to create TOD planning areas. This statute is called the Transit Village Development Planning Act of 1994 (California Planning and Zoning Law). This act provides incentives to cities and counties for planning "transit villages." Transit villages are located within a 1/4 mile of a transit station. Federal, state, and local transportation funding is given to transit village transportation projects that include mixed-use developments, pedestrian and bicycle facilities, and traffic-calming measures. Additionally, transit village plans receive expedited administrative review.

Senate Bill 375, passed in 2008, requires Metropolitan Planning Organizations (MPOs) to develop integrated land use/transportation plans to reduce rates of greenhouse gas emissions. This bill encourages compact, walkable, transit-oriented communities and discourages sprawl. The State of California's Department of Transportation is known as "Caltrans." Caltrans supports smart-growth land use/transportation planning via its Blueprint Planning Program. The Blueprint Program started in 2005 and has awarded $20 million in federal regional transportation planning funds. These funds provide financial support for MPOs and local jurisdictions for outreach, planning, and modeling. The Blueprint Program helps MPOs and Councils of Government (COGs) develop regional plans with better land use and transportation patterns that will help reduce greenhouse gasses while developing sustainable growth patterns that improve the quality of life for Californians. Caltrans supports regional blueprints by providing grants, support services, and interagency coordination.

Research and Information Sharing

In 2002, the State of California created a website that provides a database with information on TODs (Caltrans 2000). While Caltrans provides the database of TOD information, Caltrans does not fund these projects directly. This website provides TOD project

information such as land uses, site maps, implementation processes, financing, facilities, zoning, design features, pedestrian access, transit services, photos, travel benefits, contract information, and other data.

Planning Guidance

The Center for Transit-Oriented Development (CTOD) published "Creating Successful Transit Oriented Districts in Los Angeles: A Citywide Toolkit for Achieving Regional Goals" with a grant from Caltrans and the Los Angeles County Metropolitan Transportation Authority (Metro).

Research conducted by the California Air Resources Board (ARB) found that TOD and other land use strategies could generally reduce emissions by at least 10 to 20 percent in suburban communities and by at least 20 to 30 percent in central cities. ARB studies also show that "significantly increasing walking and transit opportunities," along with strategically located moderate to high-density development and transit, could achieve an annual reduction in vehicle miles traveled of between 20 to 30 percent per TOD household. Given that, a TOD household could consume 250 to 380 fewer gallons of gasoline each year, on average, and emit 2.5 to 3.7 tons less CO_2 yearly than its non-TOD counterpart.

Funding

Caltrans is involved with TOD implementation around the state via California's Proposition 1C. Proposition 1C was passed by voters in 2007 and, among other things, provided approximately $1 billion for infrastructure and housing for TODs and infill land use projects. Caltrans provided technical assistance to the State's Department of Housing and Community Development, which was the agency responsible for the implementation of the 1C funds. All of the Proposition 1C funds have been allocated, and Caltrans does not have additional funding to continue this grant program.

A second state initiative, the Community-Based Transportation Planning (CBTP) grant program, has funded some TOD projects in the past. Upon completion of each project, the CBTP will draft a fact sheet that details the basics of each grant for posting on Caltrans website. The idea behind the fact sheets is to help prospective applicants see the types of projects that

have been funded in the past and the methods and strategies used to complete the project successfully. One project that had a TOD focus was in District 11, the Smart Growth/Planning TOD, Commercial and 22nd Street Mixed Use. Below are some details taken from the fact sheet located on the website:

> ***Project Focus*** *– The Commercial Avenue and 22nd Street project site is located along the Orange line of the San Diego Trolley in Logan Heights, one of San Diego's oldest communities. A predominantly Mexican-American community with a minority population of more than 90%, Logan Heights is an economically distressed area with a median household income well below that of the City of San Diego's general population. This project was undertaken in response to a Request for Proposal from the San Diego Unified School District to develop 3.45 acres of unused district property.*

Figure 33. Logan Heights District in San Diego (CA) (Source: McLarand Vasquez Emsiek & Partners).

> ***Project Goals*** *– The project is a mixed use, multigenerational, transit-oriented development that combines affordable housing for families and seniors with day care facilities and community-serving commercial and retail space that respond to the unique physical, economic, social and cultural needs of the Logan Heights community. The project site is less than one mile from Petco Park, home of the San Diego Padres baseball team, which is located in the East Village neighborhood of San Diego. Once a blighted warehouse district, East Village witnessed a redevelopment boom. Due to the proximity of the project site to the East Village, gentrification of Logan Heights, with its potential ensuing displacement, threatened the mainly Latino residential neighborhoods adjoining the project site. Response to the threat of losing the Logan Heights community's heritage and culture was to conceptually design the smart growth project.*

Community Outreach *– Community meetings, focus group meetings, community forums, and surveys made up the bulk of outreach for this project. Additionally, ongoing Internet access to the project website was provided for community residents through the use of two refurbished computers at a local café. The "Eyes of Picasso" by local artist Mario Torero, was projected onto the abandoned school warehouse that is at the center of the project. This light projection can be seen from nearby Interstate 5 and has helped create awareness about the project and its public arts theme.*

Project Outcome *– The project is a neighborhood reinvestment development that provides needed affordable housing for families and seniors, in addition to providing health services, community serving retail, employment training, transit-oriented and brownfield infill development.*

The Commercial and 22nd Street Mixed Use project was awarded $12,660,480 for Infill Infrastructure and $5,872,126 in Transit Oriented Development (TOD) from Proposition 1C funds in July 2008. Construction is expected to begin in early 2009.

Planning Goals Realized *–*

- *Safe and healthy communities; and,*
- *Pedestrian, bicycle, and transit mobility. (Caltrans 2005)*

District of Columbia

Planning Guidance

In 2008, the District of Columbia Department of Transportation (DDOT) began the Union Station Intermodal Transportation Center (ITC) Feasibility Study. The study was completed in October 2009 with the recommendation of implementing TOD principles into the design. The following comes from the ITC Feasibility Study:

In response to a study in 2001 showing that more than three square miles of property near Metro stations in D.C. were abandoned or vacant, Mayor Anthony Williams convened a task force to study how development and design could be used to leverage the assets that Metro provides D.C. That group, the Mayor's Task Force on Transit-Oriented Development, came up with the following definition for TOD as it is conceived in the D.C.:

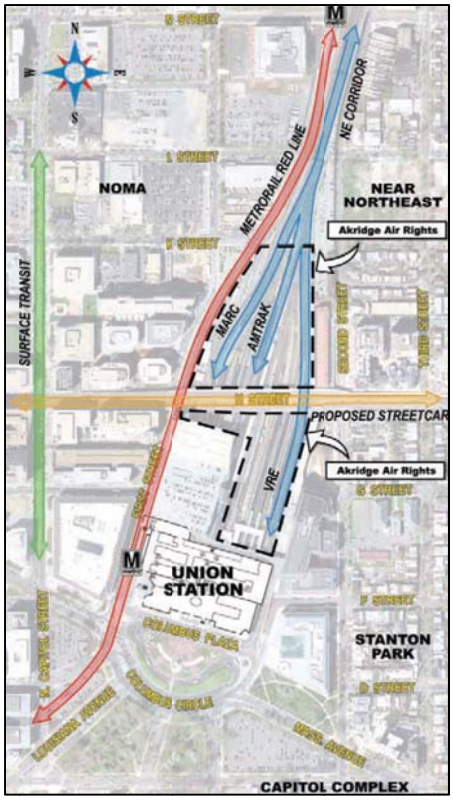

Figure 34. Project Area around Union Station (D.C.)
(Source: DDOT 2009, Chapter 2, 6).

> *Transit-oriented development (TOD) in the District of Columbia is a land use strategy to accommodate new growth, strengthen neighborhoods, and expand choices and opportunities by capitalizing on bus and rail assets to stimulate and support vibrant, compact, diverse, and accessible neighborhood centers within an easy walk of transit.*

Like sustainability, TOD is not a single principle, but instead a broad spectrum of principles and activities that can lead to successful transit areas and neighborhoods. TOD principles include:

- *Urban design*
- *Mixed land use*
- *Enhanced streetscapes and pedestrian amenities*
- *Enhanced transit*

TOD principles are an integral part of the recommendations presented in this report — every improvement works to enhance the capacity of transportation service at Union Station. Several proposed improvements in particular support TOD principles:

- *Connection of the Union Station Metrorail station to H Street via pedestrian walkway. This improvement would expand the catchment*

area of the existing Metrorail station by creating what would effectively be an additional station entrance at H Street.

- *Connection to the H Street streetcar. Incorporating streetcar facilities would add an additional transportation mode connection to Union Station and connect the H Street corridor to the facilities at Union Station. Additionally, street-level transit would activate and improve the pedestrian environment of H Street. (DDOT 2009, chapter 7, 39)*

Florida

Statutory/Regulatory Environment

Florida Department of Transportation (FDOT) is not the land planning agency for the state of Florida; this role is delegated to the Department of Community Affairs (DCA), which assists local governments in managing and regulating development in Florida. DCA reviews comprehensive plans and plan amendments for compliance with The Local Government Comprehensive Planning and Land Development Regulation Act, also known as the Growth Management Act (GMA). The GMA requires comprehensive plans to address future land use issues involving housing, transportation, infrastructure, coastal management, conservation, recreation, and open space (Florida DCA).

FDOT is involved in the review of local government comprehensive plans and plan amendments from a transportation perspective. FDOT reviews local government comprehensive plans for transportation issues and provides objections, comments, and recommendations to the DCA for inclusion in their overall reviews. FDOT also proactively works with local governments in providing technical assistance and guidance regarding transportation issues.

FDOT is involved in TODs through both its transit and rail offices. FDOT's role is to support and encourage development patterns that promote a walkable, transit friendly environment and assist in increasing ridership for the 29 Florida transit agencies. Through FDOT's commuter rail and high speed rail programs, FDOT is working directly with local governments to develop station plans and surrounding land uses and development patterns to support the rail system.

Research and Information Sharing

Florida DOT, in conjunction with DCA, is developing guidance for TODs in the form of a TOD Design Guidelines handbook (FDOT "Transit"). The handbook will set out general guidance policies and parameters for what is considered a TOD in Florida. The information in the study is derived from 10 statewide workshops conducted by FDOT. During the workshops, the state was able to vet the TOD Design Guidelines with local government, other agencies (such as metropolitan planning organizations (MPO) and transit agencies) and the public. These guidelines are proposed to be used in partnership with the FDOT to assist in promoting multimodal system planning and managing congestion on state roadways, especially on the Strategic Intermodal System.

Planning Guidance

The TOD handbook is being developed to provide model policy language and land development code language for use by local governments in establishing TOD areas in their local governments' comprehensive plans. The principles assist the local governments with complying with Florida's Growth Management Act of 2005. The handbook is currently being refined and the context in which the handbook will be used is being defined; once the handbook is finalized it will be distributed to local governments and agencies.

The Florida DOT has developed a variety of tools and undertaken efforts to promote transit-oriented design in bus as well as rail corridors throughout the state. FDOT's Transit Office produced a report entitled Accessing Transit that includes a discussion of design principles to support transit access, as well as a CD-ROM of TOD resource materials.

Funding

FDOT's District 5 office in Fort Lauderdale has funded charrettes, transportation corridor studies, and neighborhood plans that address land use issues, including TOD and transit-supportive design.

Examples of TOD Projects

The Florida Department of Transportation funded the preliminary design of a full regional multi-modal transportation center near Downtown Jacksonville (Hannan 2009). The

Jacksonville Regional Transportation Center (JRTC) facility will serve rail, bus, rapid transit (the existing Skyway system), intercity bus, parking, pedestrian, parking, and bike modes. The center will house office space, retail stores, and a well landscaped public plaza. Additionally, the center will have office space for the Jacksonville Transportation Authority administration (Jacksonville Transportation Authority 2009). The configuration was designed to promote transit-oriented development in support of the City's Master Plan.

Figure 35. Rendering of the Jacksonville (FL) Regional Transportation Center.

Illinois

Funding

Illinois DOT administers the Illinois Tomorrow Corridor Planning Grant Program, which promotes voluntary state/local partnerships and focuses on state programs that invest in existing communities. This is a five-year $15 million grant for local governments in urbanized areas. The grant is used to promote land use and transportation solutions that reduce the growth of traffic congestion. One use of the grant is to develop transit-oriented or mixed-use development plans. These funds are for planning projects only (Illinois DOT).

Examples of TOD project

***Western Springs, $100,000 for Burlington Northern Railroad Mixed Use Transit Corridor**. This project will identify the mixed-use and transit oriented development potentials along the Burlington Northern Railroad through the village of Western Springs. Issues to be addressed include: 1) the location of the current Metra station and platforms with regard to safety, access, etc.; 2) the possible development of pedestrian underpasses to provide secure pedestrian crossing; 3) traffic circulation and parking conditions within the downtown area; 4) pedestrian and bike conditions and how to improve linkages; 5) potential for new housing and business development in association with transportation improvements; and 6) streetscape enhancements. Products include 1) an intermodal facility improvement and transportation management system; 2) a land-use and development plan; 3) an implementation action agenda; and 4) a planning program to be adopted as part of the village's comprehensive land use plan. (Illinois Governor 2001)*

Figure 36. Western Springs (IL) Downtown Study Area Map
(Source: Regional Transit Asset Management System)

Maryland

Statutory/Regulatory Environment

In 2008, the State passed Senate Bill 204 creating TODs as a formal transportation purpose of the Maryland Department of Transportation (MDOT); this bill made TODs eligible to receive DOT funding similar to highways, ports, airports, and other forms of transportation

(Senate Bill 204). By authorizing TODs as a transportation purpose, MDOT is able to use departmental resources such as land, funds, and personnel to support designated TOD projects. Additionally, MDOT supported the passage of Senate Bill 274 in 2009 to create tax increment financing districts (TIF), which allow local jurisdictions to raise additional funding for TOD projects.

On June 18, 2010, the governor of Maryland designated 14 Maryland transit stations as designated sites for transit-oriented development. The designation sets these stations as priorities for state development assistance. Additionally, the governor announced that the Maryland Department of Housing and Community Development will move into Prince George's County from Anne Arundel. The new location in Prince George's County will be located near a Metro station and will be developed as a TOD (Wiggins 2010).

MDOT also pursues TODs through public/private partnerships (PPPs). MDOT invites interest in the form of unsolicited proposals for development. The Maryland Transportation Authority administers the State's Transportation Public-Private Partnership (TP3) program. TP3 initiatives are contractual agreements between government agencies and private entities to provide transportation-related goods or services to the public. These special partnerships enable government agencies and private firms to cooperatively finance, construct, or operate non-highway transportation projects that enhance the State's transportation system.

Funding

If a mixed-used development that is located within 1/2 mile of a transit station is deemed to be a transit-oriented development, the station will be eligible for public assistance through MDOT and other state agencies (Krouse 2010). Predevelopment costs, including planning, environmental studies, appraisals, financial analysis, and legal support are all ways MDOT assists TODs. MDOT owned land near the station may also be made available for the development (MDOT "Designation").

MDOT also partners with the Maryland Economic Development Corporation (MEDCo), to assist TOD projects with financing that does not impact local governments' direct debt capacity. Additionally, as mentioned above, TIFs can be created by local jurisdictions to raise additional funding for TODs.

Examples of TOD projects

The following is an example of a MDOT project with Anne Arundel County taken from the MDOT website:

> *Partnership with Anne Arundel County*
>
> *The State Department of Transportation and Anne Arundel County have joined together in partnership on developing the Odenton MARC Station, following Transit Oriented Development principles. In April, 2006, the Anne Arundel County Council passed a resolution in support of the State and County partnership for the Odenton joint development. Additionally, the County Executive signed a Memorandum of Understanding (MOU) with the State Department of Transportation to the same affect (sic) as several properties offered in the Request for Expressions of Interest included the County's properties as well, such as the East Parking Lot at the Odenton MARC Station, available excess property on the West County's Library site, and possibly the Public Works Administration lot along Duckins Road, if another site could be identified for relocation.*
>
> *. . .*
>
> *What is the Development Program (Concept) for the Odenton MARC Station?*
>
> *The intent of the proposed mix of commercial, retail and residential uses is to focus all functional aspects of development on site with minimal impact on surrounding neighborhoods. This will be achieved by a relatively high density, pedestrian-friendly development program consistent with the Odenton Town Center Master Plan.*
>
> *The $150 Million Development Program could include:*
>
> - *One hotel with 90 to 120 rooms,*
> - *74,000 square feet of retail space,*
> - *572 apartment and condominiums, including 60 units dedicated to affordable housing for seniors,*
> - *250 townhouses,*
> - *5 single family homes, and*
> - *Two or more parking garages for MARC Commuters with a total of 3,500 parking spaces and 1,245 additional parking spaces for the development. Total parking on the site will increase from 2,000 spaces to almost 5,000 (4,745) spaces.*
>
> *The mix of retail could include sit-down restaurants, quick service food purveyors, coffee shops, cleaners, a bank, a parcel drop-off store, a salon, an ice cream store, etc.*

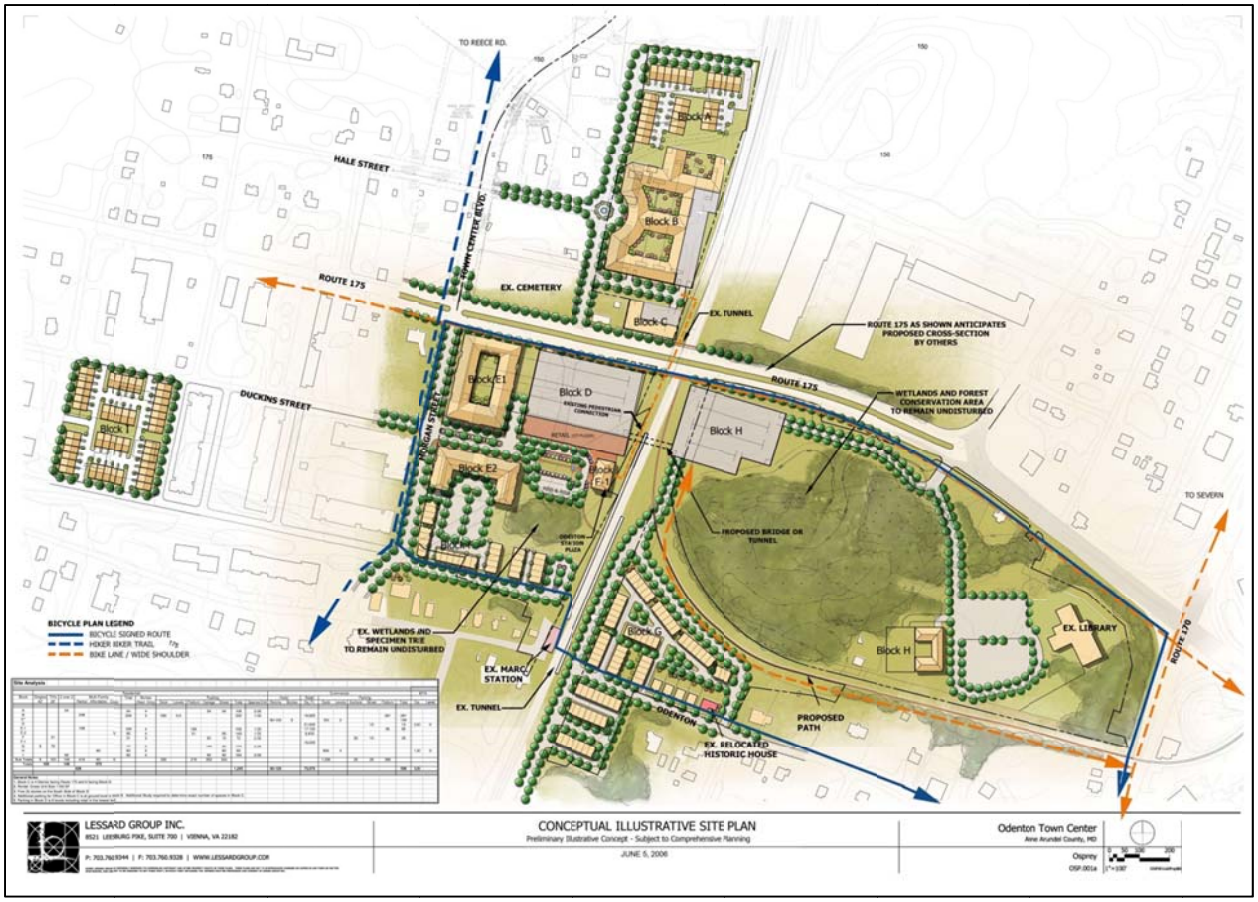

Figure 37. Odenton (MD) Conceptual Site Plan.

(MDOT "Odenton")

New Jersey

Statutory/Regulatory Environment

New Jersey's Department of Transportation (NJDOT) and NJ TRANSIT organize a multi-agency Smart Growth partnership known as the Transit Village Initiative. The Transit Village Initiative provides incentives for municipalities to redevelop or revitalize the areas around transit stations using design standards of transit-oriented development.

Since 1999, NJDOT, NJ TRANSIT, and other state agencies have actively been supporting transit-oriented development through the Transit Village Initiative, which aims to revitalize and grow selected communities with transit as an anchor. This support started when NJ TRANSIT needed to increase ridership and decided to implement "smart growth" concepts. These initiatives began by providing more parking and mixed-used development around transit areas.

While NJDOT participates in the Transit Village Initiative, no legislation has been passed regarding the DOT participating in this program (NJDOT 2009c).

Under the Transit Village Initiative, state agencies provide financial and technical resources to the 20 Transit Villages that have been designated to date. Municipalities that are designated a Transit Village are provided the following benefits:

- A commitment from the State to the municipality's vision for redevelopment.
- Coordination among the State agencies that make up the Transit Village task force.
- Priority funding from some State agencies.
- Technical assistance from some State agencies.
- Eligibility for grants from NJDOT's dedicated Transit Village funding. (The Montclair Times 2010).

The Transit Village Initiative's main goals are to increase transit use, reduce congestion, and provide affordable housing. The biggest hurdle for projects is the necessity of a shovel-ready project. Additionally, affordable housing must be created. The Housing and Mortgage Finance Agency monitors the amounts of affordable housing and has created a database to track affordable house developments. The development of affordable housing is a goal from the state for the Transit Village Initiative. In addition to community revitalization, the Transit Village Initiative seeks to reduce traffic congestion and improve air quality by increasing transit ridership.

Funding

NJDOT does not fund individual TODs but instead funds Transit Villages. A Transit Village must have multiple TODs planned for development. A task force reviews applications that are received for Transit Village Initiative. The Transit Village Task Force includes representatives from NJDOT, NJ TRANSIT, the Council on the Arts, the Department of Community Affairs, the Department of Environmental Protection, the Economic Development Authority, the Housing and Mortgage Finance Agency, the Office of Smart Growth, Main Street New Jersey, and the Redevelopment Authority. The task force meets six times a year and helps direct state funding to the designated Transit Villages. In order to be designated a Transit

Village and received state funding, a municipality must meet the following criteria, as quoted from the Transit Village website:

- *Attend a pre-application meeting with the Transit Village Coordinator*
- *Identify existing transit*
- *Demonstrate municipal willingness to grow*
- *Adopt a transit-oriented development (TOD) redevelopment plan or TOD zoning ordinance*
  - *Include transit-supportive site design guidelines*
  - *Include transit-supportive architectural design guidelines*
  - *Include transit-supportive parking regulation*
- *Identify specific TOD sites and projects*
  - *Document ready-to-go projects*
  - *Include affordable housing in the transit village district*
- *Identify bicycle and pedestrian improvements*
- *Identify "Place making" efforts near transit station*
- *Establish a management organization*
  - *Identify annual community events and celebrations*
  - *Identify arts, entertainment and cultural* events *(NJDOT 2009a)*

In previous years, the DOT allocated approximately $2 million for the Transit Village Initiative. In 2009, New Jersey had 20 TODs designated as Transit Villages, and 10 of those applied and received DOT state funding. Due to budget cuts, the 2009 fund was reduced to $0.5 million.

Examples of TOD Projects

There are currently 20 designated Transit Villages. They are Pleasantville (1999), Morristown (1999), Rutherford (1999), South Amboy (1999), South Orange (1999), Riverside (2001), Rahway (2002), Metuchen (2003), Belmar (2003), Bloomfield (2003), Bound Brook (2003), Collingswood (2003), Cranford (2003), Matawan (2003), New Brunswick (2005), Journal Square/Jersey City (2005), Netcong (2005), Elizabeth/Midtown (2007), Burlington City (2007), and City of Orange Township (2009) (NJDOT 2009b).

> *South Orange, like many older suburban communities, suffered from years of decline in the 1970s and 1980s. In 1994, the Village Council adopted a redevelopment plan to take advantage of the town's main asset: its train station.*

The plan called for renovations to the historic station, improvements to the pedestrian environment downtown and a strategy to attract new development.

Figure 38. South Orange (NJ) Streetscape.

Ten years of hard work have transformed South Orange's neglected downtown into a thriving community center. The train station has been modernized, along with commuter-oriented retail shops and restaurants. Streetscaping, decorative lighting and urban art have created a pleasant pedestrian environment. Nearly 350 apartment units (with limited parking facilities) and a new theater-arts complex have been built. Streets are lively with pedestrians during the day and at night. South Orange has become a very desirable place to live: in fact, residential real estate values for properties within one-half mile of the train station doubled in value between 1993 and 2003.

Figure 39. Bicycle Parking in South Orange (NJ).

(NJDOT 2005)

More recently NJDOT has designated Montclair and Somerville as Transit Villages, which allows them to apply for up to $100,000 in planning and technical assistance grants through NJDOT (Baldwin 2010).

New York

New York State is working on approving a smart growth bill, the State Smart Growth Public Infrastructure Policy Act, which passed the State Senate on Friday, June 22, 2010. The law will require that all state infrastructure spending comply with smart growth principles, including directing spending toward already developed areas or growth zones designated in local comprehensive plans. The policy specifically calls for the advancement of projects in municipal centers (which can include TODs) and the prevention of sprawl (Assembly Bill A08011).

Oregon

Statutory/Regulatory Environment

Oregon Administrative Rule (OAR) 660-012 defines planning roles for the local government agencies. OAR 660-012 calls for planning that reduces reliance on automobiles

and specifies that land uses, such as transit-oriented developments, should be allowed on lands along transit routes.

Planning Guidance

The Portland area regional government is known as "Metro." Oregon Department of Transportation (ODOT) has a seat on Metro's Transportation Policy Alternatives Committee, which provides technical input on transportation funding and priorities for the Portland metropolitan region. Metro is in the process of approving its 2040 Regional Transportation Plan (RTP). ODOT will provide technical input for the planning agency by determining the trips that will be produced by the development. When a mixed-use development is presented, ODOT can assume reduced number of trips to help get approval for the project. The main goal of the transportation plan will be to look at land use first, then building out the project with targets for minimum densities that encourage TODs.

Funding

Since 1993, ODOT has provided Transportation and Growth Management Grants (TGM) for planning. These grants help link land use and transportation planning by creating a partnership with local governments to create livable places where people can walk, bike, use transit and drive where they want to go. These grants are administered by ODOT and the Department of Land Conservation and Development. The grants are competitive and the TODs must apply for the grants. The transportation planning must focus on the use of alternative modes for transportation and land use management.

Example Project

The Oregon Department of Transportation serves as a member of the TOD steering committee established by the Metro Council. The Center Commons is a TOD developed by Metro TOD. According to Metro, one highlight of this project is that it was the first in the U.S. to be funded with FTA funds for the purchase and sale of property in escrow to achieve a land value write-down (Metro Regional Government 2010). The land used for Center Commons was an abandoned ODOT transportation maintenance yard. The land for the project is located immediately adjacent to I-84 Freeway and is about a 1/4 mile from the 60th Avenue MAX light-

rail station. Also, Center Commons is located within a 1/3 mile from three Tri-Met bus routes (Cervero et al. 2004).

In 1995, the Portland Development Commission (PDC) performed a feasibility study for a TOD and proceeded to purchase the land from ODOT at fair-market value. In 1999, the project was threatened by economic conditions and the Metro TOD program purchased the site for $1 million. The parcel was subdivided, then sold after the land was reduced in value to $250,000 to reflect current market conditions. Remediation was needed for the site due to soil contamination and asbestos. ODOT provided assistance with the remediation project, which started in April 1999.

The project, which included 288 apartments (including low income units), ground-floor commercial, a daycare center, and 26 townhomes, opened in 2001. Reportedly, 46 percent of residents of this TOD use transit services for work trips and 32 percent for non-work trips, which is significantly higher that previous residents' levels.

Pennsylvania

Funding

In 2009, as part of the Pennsylvania Community Transportation Initiative (PCTI), Pennsylvania's governor announced $76 million to create green jobs and sustainable communities (PennDOT 2009). Projects approved for this funding, administered through PennDOT, included projects for planning and construction for revitalizing downtowns, multi-use trails, traffic calming, and transit-oriented development studies. The following two plans received funding from this initiative:

- Abington Township received $275,000 to plan for transit-oriented development at the Noble Train station.
- Red Rose Transit Authority received $2,000,000 to expand an existing transit terminal and partner with a private entity to build transit-oriented development that will increase transit ridership and generate operating revenue for the authority.

Washington

Statutory/Regulatory Environment

Washington State has enacted several laws over the last two decades that are aimed at reducing car trips and CO_2 emissions in the area. In 1990, the State enacted the Growth Management Act (GMA), which requires the fasted growing counties and cities within those counties to plan extensively for issues like sprawl reduction, concentrated urban growth, affordable housing, economic development, open space/recreation, regional transportation and environmental protection. The GMA provides a framework for regional coordination, and counties planning under the GMA are required to adopt county-wide planning policies to guide plan adoption within the county and to establish urban growth areas (UGAs). Local comprehensive plans must include the following elements: land use, housing, capital facilities, utilities, transportation, and, for counties, a rural element (MRSC 2009). The GMA addresses the negative consequences of unprecedented population growth and suburban sprawl in Washington. The GMA requires all cities and counties in the state to do some planning to reduce sprawl and has more extensive requirements for the largest and fastest-growing counties and cities in the state. The GMA requires the inclusion of transportation and capital facilities plans with all land use plans.

In 2006, the state passed the Commute Trip Reduction Efficiency Act (CTR) requiring local governments in Clark, King, Kitsap, Pierce, Snohomish, Spokane, Thurston, Whatcom, and Yakima Counties (counties experiencing the greatest automobile-related air pollution and traffic congestion) to develop and implement plans to reduce single-occupant vehicle trips (WSDOT 2010a).

The CTR has created collaborations between the nine counties with the greatest pollution and congestion, employers in the counties, and WSDOT (Washington State's Department of Transportation). The counties, and local cities, are required to adopt CTR ordinances and support local employers in implementing CTR. Employers in those counties must participate in CTR if they have 100 or more full-time employees at a single worksite who begin their scheduled workday between 6 and 9 a.m. (Most construction and seasonal agricultural workers are exempted.) More than 1,110 worksites and more than 560,000

commuters statewide participate in the CTR Program. These employers are required to develop a commuter program designed to achieve reductions in vehicle trips and may offer benefits such as subsidies for transit fares, flexible work schedules, telework opportunities, and more (WSDOT 2010a).

According to WSDOT, Growth and Transportation Efficiency Centers (GTECs) bridge the gap between the Growth Management Act (GMA) and the CTR law. A GTEC is a defined boundary of dense mixed-use development with major employers, small businesses, and residential units within an established urban growth area. The goal of the GTEC program is to provide greater access to employment and residential centers while decreasing the proportion of commuters driving alone during peak periods on the state highway system. From 2007 to 2009, the WSDOT collaborated with local governments, transit agencies, and businesses to encourage TOD-like developments. While the statewide CTR program focuses on commuters traveling to major employers, GTECs provide commute options programs to smaller employers, residents, and students that are clustered in and around transit stations; GTECs also worked to find new ways to encourage commuters to ride transit, vanpool, carpool, walk, bike, work from home, and use other commute options besides driving alone (WSDOT 2010b). Common program elements include trip reduction incentives, transit passes, outreach and information for commuters, small-scale infrastructure investments, and local policy development and implementation.

The state allows jurisdictions the option of designating and planning for GTECs in areas of dense population and employment, with potential state funding for implementing the plans. The GTEC plans that are the most developed and have received funding from WSDOT are in Bellevue, Seattle, Spokane, Olympia, Tacoma, Redmond, and Vancouver. Three other GTECs exist but are not as well developed or funded by WSDOT: Puyallup, Kirkland and Tukwila.

GTEC programs must have the following elements to receive state funds:

- Goals for reductions in drive-alone trips and VMT that are more aggressive than the CTR program goals or that include more employees than would be included by the CTR program alone.
- Short- and long-term strategies for achieving the goals.
- A measurement and performance monitoring plan.

- A financial plan demonstrating how the program will be funded from public and private sources (state funds require a 50 percent local match).
- An organizational structure for implementing the program, including partnerships with businesses and transit agencies.
- An evaluation of local land use and transportation policies to determine the extent to which they complement and support trip reduction efforts.

Funding

GTEC grants provided seed money to local areas to plan and implement these transit-oriented projects.

Examples of TOD Projects

The City of Spokane has a GTEC that focuses on the Downtown Business District and the close-by University District. While a GTEC is not specifically a TOD, the plans for the GTEC include TOD components. The program started in the fall of 2008 through the Mayor's office, the Chamber of Commerce, and the Downtown Spokane Partnership. Additionally, the Spokane's Planning Services Department and the Spokane County Commute Trip Reduction Office joined the program to increase transportation efficiency within the GTEC.

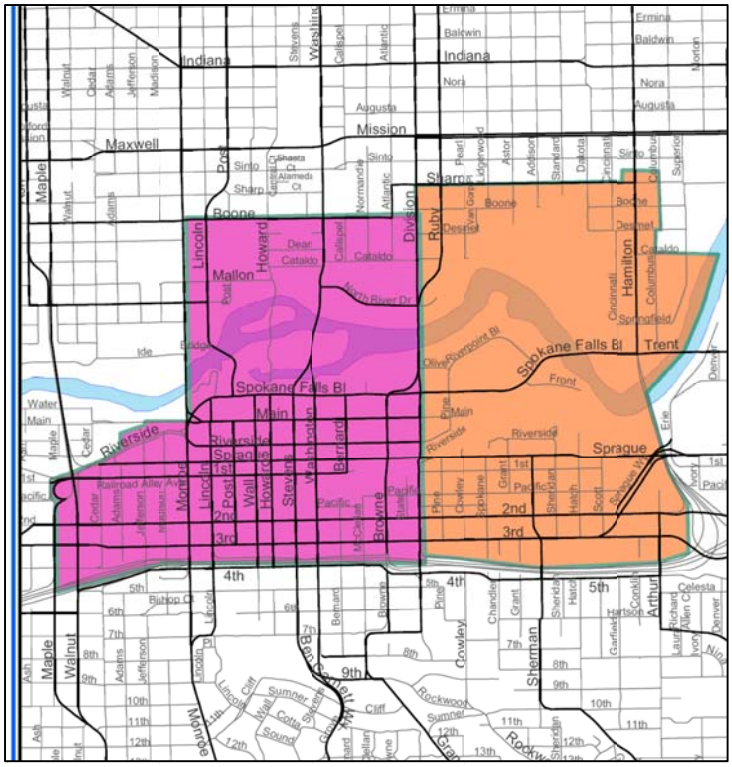

Figure 40. Spokane's (WA) Downtown District GTEC.

A comprehensive plan was established to assist Spokane in implementing its GTEC. The following is an excerpt from the plan regarding capital improvements:

> *The transportation element of the Comprehensive Plan shows a strong correlation between transportation and land use, urban design, neighborhood planning, and social health. The plan also identifies these key issues:*
>
> - *In the future increasing numbers of people may not physically or financially be able to drive.*
> - *Continued dependency on driving may not be sustainable in the future, either economically or environmentally.*
> - *Designing Spokane around the automobile decreases people-friendly environments and erodes the quality of community.*
>
> *The focus of the comprehensive plan goals and policies is to increase transportation choices and reduce dependency on driving. The intent, however, is not to eliminate automobile use but to provide people with viable options to driving. The key values for the Transportation Element included the following issues that relate to effective implementation of the CTR program and GTEC plan:*
>
> - *Ensuring mobility and access within the city.*
> - *Decreasing north-south congestion.*
> - *Increasing the variety and public awareness of transportation choices.*
> - *Developing and maintaining good public transit.*

- *Developing and maintaining pedestrian-oriented neighborhoods.*
- *Developing convenient access to the downtown area, increasing parking, bus service, light rail, and satellite parking with shuttles, and improving the pedestrian environment.*

The land use section of the City's Comprehensive Plan describes the City's vision for land use as "Growth will be managed to allow a mix of land uses that fit, support, and enhance Spokane's neighborhoods, protect the environment, and sustain the downtown area and broaden the economic base of the community." Some of the associated values that relate to the CTR program and the GTEC plan include:

- *Controlling urban sprawl in order to protect outlying rural areas.*
- *Developing and maintaining convenient access and opportunities for shopping, services, and employment.*
- *Protecting the character of single-family neighborhoods.*
- *Guaranteeing a variety of densities that support a mix of land uses.*
- *Utilizing current residential lots before developing raw land.*

The land use section explains that the future growth of the city will occur within neighborhood centers, district centers, employment centers and corridors designated on the land use plan map, leaving single-family residential neighborhoods largely unchanged. The centers and corridors contain a mix of uses, including higher density housing around or above retail and commercial establishments, office space and public and semi-public activities (parks, government and schools). Streets within the centers and surrounding neighborhoods enable residents to walk or bicycle for their daily service needs and to access each center's transit stop. Higher density housing and office buildings within and around the centers supports business in the center and allows for enhanced transit service between centers, along corridors and to the downtown area. (City of Spokane 2007)

VIII. RECOMMENDATIONS FOR BETTER INTEGRATING TRANSIT-ORIENTED DEVELOPMENT INTO THE STATE'S OVERALL TRANSPORTATION PLAN

Transit-oriented development is increasingly recognized as a desirable land form for urban and suburban development. Demand for TOD by residential and commercial tenants has increased greatly in a relatively short time in Texas, and there is every indication that this demand will continue to increase. The findings of our survey of TOD residents show that their choice of housing is influenced most greatly by factors associated with proximity to work and lifestyle choices. The lifestyle choices include convenience to dining, shopping, and entertainment venues, availability of parking, and living in a residence that represents an "urban lifestyle." Though somewhat lower than these factors, proximity to a rail transit station is considered important. Whether residents move into TOD specifically for convenient access to transit services or because of other characteristics of TOD living, the findings presented in this report clearly show a substantial shift in transportation facility use, route choices, and VMT after moving into TOD residences.

Overall, residents moving in TOD properties reduce average household miles driven by about 3,500 miles per year, a 15 percent reduction. Though there are substantial differences in the total reduction of VMT among the three study areas examined in this research, all showed a drop in both highway and non-highway miles driven with implications for TxDOT facility usage and motor fuel tax revenues. Based on our inventory of TOD properties, there are about 8,000 TOD residential units in the service area of DART, the Fort Worth TRE, and Capital Metro suggesting that the total current effect of TOD on VMT is a reduction of about 28 million miles and that total fuel tax revenues are lowered by just less than $200,000 per year. While the total effects are comparatively small at this time, continued growth of TOD suggests that the attendant reduction in highway use by TOD residents be taken into consideration by TxDOT for planning, modeling, project design, and issues related to TxDOT revenues.

Relatively few state transportation agencies across the U.S. are involved in issues dealing directly with TOD. Most of the state agencies involved in TOD address issues dealing with the statutory and regulatory development environment for TOD, offering planning guidance to cities, MPOs, and others, and providing funding for planning and/or development

activities. California and Florida are also engaged in research and information sharing activities concerning the development of TOD projects.

In the following we offer recommendations for TxDOT staff to consider as possible action items and/or as changes to TxDOT manuals that incorporate relevant findings of this research.

Recommendations for Project Development Planning

In December 2008, the Urban Thoroughfare Committee recommended that the Texas Transportation Commission adopt various modifications to TxDOT's *Project Development Process Manual* to promote "context sensitive solutions" that address urban transportation challenges. The research presented here suggests that TOD can be one of those solutions that alter traditional relationships in travel behavior, and therefore, there may be opportunities to modify the *Project Development Process Manual* to promote future TOD projects. There are at least two key areas from TxDOT's planning perspective where it can promote TOD development.

First, the increasing incidence of TOD and its impact on travel behavior calls for enhanced integration of efforts between TxDOT and regional transit authorities, especially those transit agencies that have, or plan to have, significant transit rail components in their systems. It is widely recognized that modern sustainable community design includes greater emphasis on rail transit. The siting of transit rail stations, and attendant TOD projects, calls for a very high level of coordination among TxDOT, MTAs, and MPOs on how rail and road transportation systems will intersect. However, even improved transportation planning efforts are not sufficient for realizing the potential gains related to increasing the incidence of TOD as a land use. Higher density urban designs, like TOD, will require significant changes in land use planning and zoning by major Texas cities and their suburbs. The Texas Department of Transportation needs to engage actively with communities to promote understanding of the relationship between transportation efficiency and urban land use. To help institutionalize awareness of how TOD projects can affect coordinated transportation planning efforts, we

suggest the following as possible wording for a modification/addition to the TxDOT *Project Development Process Manual*:

> Section 1380: Institutionalization of Coordination/Partnerships in Project Development
>
> **1380. Institutionalization of Coordination/Partnerships in Project Development**
> Different vehicles for sustaining these partnerships may function better in different circumstances. These partnerships and project coordination can result in:
>
> - An opportunity to leverage and target TxDOT's resources to projects that improve a region's overall transportation network, in terms of mobility, efficiency, and reduced VMT. In some cases, financial contributions by TxDOT can be leveraged to attract funding from other sources, which will allow TxDOT to meet its objectives at a reduced cost.
> - Support coherent long-term land use plans and zoning efforts, especially along transportation corridors and around TOD developments, to maximize their potential for success.

Importantly, TxDOT staff can provide technical assistance to local planners and developers during the design phase of a TOD project that could greatly enhance transportation effectiveness and efficiency across multi-modal transportation plans. Because TOD is often located near highways and/or major arterial roads, having input from TxDOT in designing TOD friendly zoning and overlay district design standards could greatly help communities achieve overall transportation efficiency.

The second opportunity for planning improvement offered by TOD is in regards to the availability of funding for planning. As illustrated in our review of the involvement of other state and federal agencies in TOD, there are specific planning grants that target new-urbanism and sustainable designs including Partnership for Sustainable Communities program, TIGER II, and Sustainable Community Challenge Grants. Section 1370 of the Project Development Process Manual could be amended to include specific language encouraging planners to seek planning and implementation funding based on the presence of TOD.

Recommendations for Design

The need for designing road infrastructure to accommodate multi-modal transportation options, and generally urban designs with higher development densities, is widely recognized. Given the proximity of many TOD projects to highways and major thoroughfares, it is possible, even likely, that TOD brings pedestrians and bicyclists in closer proximity to vehicle traffic. The TxDOT Design Manual could be expanded to include specific operating and safety characteristics associated with TOD that impact effective and efficient roadway design. Also, the forecasted expansion of TOD and related increase in rail transit service usage suggests that rail transit services will have to increase the volume and frequency of trains to meet growing demand. This increase in rail activity could alter preferred design standards for rail-roadway intersections.

Recommendations for TxDOT Participation in TOD

The findings of this research suggest that TOD projects negatively impact TxDOT's revenues. While small at the moment, the negative impacts on revenues become meaningful if the pace of TOD as an urban form choice continues to accelerate. As noted in Section VII of this report, there are several state transportation agencies that provide funding to support TOD planning and/or project development. Given TxDOT's ongoing challenge to meet the state's mobility needs with an increasingly problematic revenue source (motor fuel taxes), it is unlikely that TxDOT will have the budget freedom anytime in the foreseeable future to financially support the creation of new TOD projects. Our recommendation is based on an alternative financial premise, exploring ways for TxDOT to extract value from TOD projects. The conclusions of the Urban Thoroughfare Team in their December 2008 report noted the potential of context sensitive solutions to capture billions in additional value, presumably meaning that local governments and private enterprises would be the recipients of this value. While the Urban Thoroughfare Team was specifically referring to value from outside the right-of-way line, there may exist opportunities for TOD and related development to occur within TxDOT-owned right of way. TxDOT RTI project number 0-6634 started in fiscal year 2011 is studying options for TxDOT to extract value from its right of ways. As Project 0-6634 is

undertaken, it should be considered if there are opportunities for TxDOT to promote TOD in right of way areas without interfering with transportation safety and efficiency. There are transit agencies in Texas looking to actively participate in commercial property development on land controlled or owned by the transit agencies. Additional research into the potential for TxDOT to participate in public, and public-private partnerships that support the development of TOD, as a part of an integrated solution to transportation challenges, could specifically examine relevant models in other states and recommend approaches for TxDOT's financial participation in TOD under state law and regulation. If this approach were to prove to be a feasible source of future revenues for TxDOT, the *Right of Way Manual, Volume 5, Property Management*, would potentially need to be modified. Section 1 of this manual specifically calls for the prohibition of leasing right of way properties for residential land uses.

Recommendations for Information Dissemination

The findings of the research reported here could prove beneficial to managers, planners, and engineers in TxDOT offices across the state. Disseminating the findings will potentially support improved understanding and decision making when including TOD properties in plans and interactions with local planners and private developers. The creation of a web document highlighting key findings of this research would offer a cost efficient means of informing key TxDOT personnel about the influence of TOD on facility use and revenues. In addition, as the incidence of TOD properties grows, traffic generation models could be adapted to account for the differential travel behaviors of TOD residents. This information would likely be highly useful to engineers and planners at MPOs, especially those with existing rail transit systems.

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APPENDIX 1: CONTROL GROUP SURVEY INSTRUMENT

1. Are you employed fulltime, part-time, presently unemployed, retired, or are you a student, or homemaker?

1. FULLTIME
2. PART-TIME
3. UNEMPLOYED (SKIP TO Q6)
4. RETIRED (SKIP TO Q6)
5. STUDENT
6. HOMEMAKER (SKIP TO Q6)
9. NR/DK (SKIP TO Q6)

2. In the *past year* have you *ever* used any of the following methods to get to [work/school]?

	YES	NO	DK/NR
a. Your own car	1	2	9
b. A carpool or vanpool	1	2	9
c. A public bus	1	2	9
d. A DART light rail train	1	2	9

2a. You indicated that you use [*insert each "yes" from* Q2] for getting to [work/school]. Do you use *[insert]* for that purpose . . .

1. At least once a week
2. A few times a month
3. Once a month
4. A few times a year
5. Once a year or less

2b1. (IF Q2a=1) How many times a week on average? ____
2b2. (IF Q2a =2) How many times a month on average? ____
2b3. (IF Q2a = 3,4) How many times a year on average? ____
2c. How do you usually get from home to the rail stop?

1. Walk
2. Drive own car
3. Dropped off by someone else in a car (carpool/vanpool included)
4. Bus
5. Bicycle

IF Q2 (car)=YES ASK Q3 (OTHERWISE SKIP TO Q4)

3. How much drive time does it take you to drive to [work/school] from your home?
Hours/Minutes _____:_____

4. How many miles is it from your home to your workplace? _____

5. How many of the ____ miles that you travel to [work/school] are traveled on a highway?

6. Can you give me the zip code of your work place?

<1> YES _____ **(SKIP TO Q7)**

<2> NO

6a. Can you tell me the city? _____

Can you give me the nearest major intersection? _____

7. In the past year have you used a DART bus or light rail service for any purpose *other than* commuting to work?

1. YES
2. NO (SKIP TO NEXT TOPIC)
9. DK/NR (SKIP TO 11)

8. Have you used the DART light rail system for any of the following reasons?

	YES	NO	DK/NR
a. Transportation to sporting events	1	2	9
b. Transportation to entertainment places	1	2	9
c. Transportation to shopping areas	1	2	9
d. Anything else?	1	2	9

FOR EACH "YES" in Q8 or "YES" in Q2d, ASK THE FOLLOWING SERIES OF QUESTIONS
[Fill with: work/sporting events/entertainment places/shopping areas]

9. You indicated that you use the light rail system for getting to [place]. Do you use the rail system for that purpose . . .

____1 At least once a week
____2 A few times a month
____3 Once a month
____4 Once every few months
____5 Once a year or less

10a. (IF Q9=1) How many times a week on average? ____
10b. (IF Q9=2) How many times a month on average? ____
10c. (IF Q9 = 3,4) How many times a year on average? ____

11. In the last three months, have you walked from your house to an entertainment venue, restaurant or shopping location?

1. YES
2. NO
9. DK/NR

In the demographics section we will ask:

Can you give me the nearest major intersection to your home?

_____

APPENDIX 2: TOD RESIDENT SURVEY INSTRUMENT

The instrument shown below is for the DART service area. Separate instruments with changes for Fort Worth and Austin are not shown. Other than specific references to host cities, the survey instruments are the same.

Transportation and Quality of Life Survey

The purpose of this survey is to understand how people use different types of transportation and why. The information collected will help improve traffic planning in this region and throughout Texas. All your responses will be treated confidentially. Only the research team will have access to your individual responses and all results will be reported as percentages or averages. This project has been approved by the UNT Institutional Review Board. If you have any questions, you may call us at 800-687-7055.

Directions: Please indicate your answers by circling or checking your responses to the questions.

1. Which of the following best describes your personal situation?

- ☐1 Work full-time
- ☐2 Work part-time
- ☐3 Self employed
- ☐4 College student
- ☐5 None of the above

If you answered "none of the above" skip to question 12 on page 3.

If you are a college student and do not work, answer questions 2 through 11 substituting "school" for "work."

Commuting to Work

2. In the *past 12 months* have you *ever* driven a **car** alone to get to work? ☐1 Yes (answer 2a) ☐2 No (skip to 3)

2a. How often did you drive a **car** alone to get to work?

- ☐1 Once a week or more ⇨ How many times a week on average? ___
- ☐2 A few times a month ⇨ How many times a month on average? ___
- ☐3 A few times a year ⇨ How many times a year on average? ___

3. In the *past 12 months* have you *ever* used **a carpool or vanpool** to get to work?

☐1 Yes (answer 3a)
☐2 No (skip to 4)

3a. How often did you use **a carpool or vanpool** to get to work?

☐1 Once a week or more ⇨ How many times a week on average? ___

☐2 A few times a month ⇨ How many times a month on average? ___

☐3 A few times a year ⇨ How many times a year on average? ___

4. In the *past 12 months* have you *ever* **walked** to work?

☐1 Yes (answer 4a)
☐2 No (skip to 5)

4a. How often did you **walk** to get to work?

☐1 Once a week or more ⇨ How many times a week on average? ___

☐2 A few times a month ⇨ How many times a month on average? ___

☐3 A few times a year ⇨ How many times a year on average? ___

5. In the *past 12 months* have you *ever* ridden a **bicycle** to work?

☐1 Yes (answer 5a)
☐2 No (skip to 6)

5a. How often did you ride a **bicycle** to get to work?

☐1 Once a week or more ⇨ How many times a week on average? ___

☐2 A few times a month ⇨ How many times a month on average? ___

☐3 A few times a year ⇨ How many times a year on average? ___

6. In the *past 12 months* have you *ever* used a **DART bus** to get to work?

☐1 Yes (answer 6a and 6b)
☐2 No (skip to 7)

6a. How often did you use a **DART bus** to get to work?

☐1 Once a week or more ⇨ How many times a week on average? ___

☐2 A few times a month ⇨ How many times a month on average? ___

☐3 A few times a year ⇨ How many times a year on average? ___

6b. How did you usually get from home to the bus stop?

☐1 Walk
☐2 Drive car
☐3 Dropped off by someone
☐4 Train
☐5 Bicycle

7. In the *past 12 months* have you *ever* used a **DART train or TRE train** to get to work?

☐1 Yes (answer 7a and 7b)
☐2 No (skip to 8)

7a. How often did you use **a DART train or TRE train** to get to work?

☐1 Once a week or more ⇨ How many times a week on average?____

☐2 A few times a month ⇨ How many times a month on average?____

☐3 A few times a year ⇨ How many times a year on average? ____

7b. How did you usually get from home to the rail stop?

☐1 Walk
☐2 Drive car
☐3 Dropped off by someone else
☐4 Bus
☐5 Bicycle

8. Circle the response that best represents your opinion to this statement: "I like the idea of taking a rail system to work."

Strongly Disagree	Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

9. How much time does it take you to drive to work from your home? Hours/Minutes _____:_____

10. How many miles is it from your home to your work? _____ miles

10a. How many of the miles that you travel to work are traveled on a highway? _____ miles

11. Your workplace zip code _____

(If zip code is unknown, describe city/nearest major intersection _____/_____)

Other Travel

12. In the *past 12 months* have you *ever* used **a DART bus or rail service for any purpose** other than commuting to work?
☐1 Yes (answer 13)
☐2 No (skip to 16)

13. In the *past 12 months* have you *ever* used a DART bus or rail service to get to a **sporting event**?
☐1 Yes (answer 13a)
☐2 No (skip to 14)

13a. How often did you use a DART bus or rail service to get to a **sporting event**?

☐1 Once a week or more ⇨ How many times a week on average? ___

☐2 A few times a month ⇨ How many times a month on average? ___

☐3 A few times a year ⇨ How many times a year on average? ___

14. In the *past 12 months* have you *ever* used a DART bus or rail service to get to **dining/entertainment places**?
☐1 Yes (answer 14a)
☐2 No (skip to 15)

14a. How often have you used a DART bus or rail service to get to **dining/entertainment places**?

☐1 Once a week or more ⇨ How many times a week on average? ___

☐2 A few times a month ⇨ How many times a month on average? ___

☐3 A few times a year ⇨ How many times a year on average? ___

15. In the *past 12 months* have you *ever* used a DART bus or rail service to get to **shopping areas**?
☐1 Yes (answer 15a)
☐2 No (skip to 16)

15a. How often have you used a DART bus or rail service to get to **shopping areas**?

☐1 Once a week or more ⇨ How many times a week on average? ___

☐2 A few times a month ⇨ How many times a month on average? ___

☐3 A few times a year ⇨ How many times a year on average? ___

16. In the *past three months*, have you **walked** from your house to an entertainment venue, restaurant or shopping location?
☐1 Yes
☐2 No

17. Before moving to your current residence, did you live within a 10-minute walk or a ¼ mile of a rail transit station?
☐1 Yes
☐2 No

Since moving to your current residence, has your use of the following types of transportation increased, decreased or generally remained the same? (if you did not use a particular type of transportation at either residence, then your use on that item would "remain the same.")

	Increased	Remained the Same	Decreased	Please estimate the number of miles increased/decreased per week.
18. Driving a car	1	2	3	_____
19. Carpool/Vanpool	1	2	3	_____
20. DART bus	1	2	3	N/A
21. DART or TRE rail	1	2	3	N/A
22. Walking	1	2	3	N/A
23. Bicycling	1	2	3	N/A

24. How many of the miles increased or decreased in question 18 were highway miles? _____

25. How many of the miles increased or decreased in question 19 were highway miles? _____

Lifestyle and Transportation Experiences

Rate the following factors on how important they were in your choice to purchase or rent your current home by circling the number that best represents your answer.

	Not Important	Of Little Importance	Moderately Important	Important	Very Important
26. Urban lifestyle	1	2	3	4	5
27. Close to restaurants	1	2	3	4	5
28. Close to a DART rail station	1	2	3	4	5
29. Parking availability	1	2	3	4	5
30. Close to a DART bus stop	1	2	3	4	5
31. Availability of shopping	1	2	3	4	5
32. Close to various forms of entertainment	1	2	3	4	5
33. Closer to work	1	2	3	4	5
34. Other:					

Rate your level of agreement or disagreement with the following statements.	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
35. The routes I drive to the places I go are usually congested.	1	2	3	4	5
36. I know how to use the DART rail system	1	2	3	4	5
37. The DART rail system goes to most of the locations I need it to go.	1	2	3	4	5

38. DART rail provides a safe environment for my travel.	1	2	3	4	5
39. DART rail offers a high-quality of transit service.	1	2	3	4	5
40. DART rail schedules are convenient to my needs.	1	2	3	4	5
41. During rush hour, I believe taking DART rail to downtown Dallas would be faster than driving.	1	2	3	4	5

Thank you for your time.

Please return this questionnaire in the envelope provided or mail to:
UNT Survey Research Center ● 1155 Union Circle #310637 ● Denton, TX 76203

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