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How Does Transportation Affordability Vary Among TODs, TADs, and Other Areas?

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HOW DOES TRANSPORTATION AFFORDABILITY VARY AMONG TODS, TADS, AND OTHER AREAS?
Final Report

NITC-RR-859

by

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16. Abstract

Transit-oriented development (TOD) has gained popularity worldwide as a sustainable form of urbanism; it concentrates development near a transit station so as to reduce auto-dependency and increase ridership. Existing travel behavior studies in the context of TOD, however, are limited in terms of small sample size, inconsistent TOD classification methods, and failure to control for residential self-selection. Thus, this study has three research questions. First, how can we distinguish between Transit-oriented development (TOD) and Transit-adjacent development (TAD)? Second, how do travel behaviors vary between TODs and TADs? Third, how does transportation affordability vary between TODs and TADs? This study utilizes cluster analysis to classify station area types and propensity score matching to control residential self-selection.

From cluster analysis with built-environment factors—density, diversity, and walkability—in a half-mile buffer, this study classifies existing station areas as TOD, TAD or Hybrid types. After controlling for residential self-selection, it shows that a TOD motivates its residents to walk more and take transit more while using personal vehicles less. The significant difference between TOD and TAD in both VMT and the number of auto trips demonstrates that TODs make the personal vehicle trips shorter and fewer. Travel behavior in the Hybrid type demonstrates the possibility of gradual and practical change. Finally, the percentage of household income spent on transportation is lower in TOD households than TAD households. This shows that a TOD household is likely to save enough money on vehicle ownership and use that, while it likely spends more on transit, the final result is a significantly lower financial burden from transportation.

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EXECUTIVE SUMMARY

Transportation has increased from the sixth-largest expenditure (less than 2%) in U.S. household budgets in 1917 to the second-largest since the 1970s (17% in 2014; U.S. Bureau of Labor Statistics, 2014). In recent decades, transit-oriented development (TOD) has gained popularity worldwide as a sustainable form of urbanism; it concentrates developments near a transit station so as to minimize auto-dependency and maximize ridership. This study defines TOD as any dense, mixed-use, and walkable area near a transit station, and transit-adjacent development (TAD) as any low-density, single-use, and car-dependent area near a station. A TOD project should give people more transportation options and thereby decrease their transportation cost.

Existing TOD studies, however, have limits: 1) limited number of study sites, 2) no systematic method to distinguish TOD from other types of station area, and 3) no control for the impact of residential self-selection on travel behavior. This study has three research questions. First, how can we distinguish between TOD and TAD? Second, how do travel behaviors vary between TODs and TADs? Third, how does transportation affordability vary between TODs and TADs?

To answer these questions, we utilize cluster analysis to classify station area types and propensity score matching to control for residential self-selection. For better generalizability, the data are collected from household travel surveys in eight urban areas across the U.S.—Atlanta, Georgia; Boston, Massachusetts; Denver, Colorado; Miami, Florida; Minneapolis-St. Paul, Minnesota; Portland, Oregon; Salt Lake City, Utah; and Seattle, Washington. From the travel survey data in the eight regions, we calculated automobile trips, vehicle miles traveled (VMT), transit trips and walk trips by individual households.

This study consists of three steps. First, following the definition of TOD and the literature review, we classify station areas based on three built-environment characteristics of TOD—density, diversity, and walkability. The cluster analysis separates station areas into three types. The first cluster (107 out of 549 station areas) is titled "TAD" and has the lowest levels of activity density; land use diversity; and walkability, as measured by intersection density. The second and largest one (n=382) is classified "Hybrid"; it has low activity density and intersection density, but the highest land use entropy index. The final cluster (n=60), "TOD," has the highest activity density and intersection density, and a high level of land use diversity. We observe that households living in TADs have more household members, more workers, and higher incomes than those living in TODs or Hybrids. Regarding travel behavior, TAD households have much higher VMT and more auto trips, and fewer transit and walk trips than those in TODs and Hybrids. Hybrid households are in the middle for most measurements, except for their lowest household incomes and highest level of transit trips on average.

Second, from the household travel surveys, we select households living in each type of station area. As significant differences among the households of a station area type could make it hard to evaluate the true impact of built environment on travel behavior, this study utilizes propensity score matching (PSM) to make samples comparable and, thus, control residential self-selection. By controlling six explanatory variables—household size, the number of workers, household

income, distance to nearest transit station, regional job accessibility, and the regions, PSM matched household pairs in three area-type couplets (TOD-TAD, TOD-Hybrid, and TAD-Hybrid). Although the differences in travel outcomes become less dramatic after controlling for self-selection, the matched samples still show that TOD motivates its residents to walk more and take transit more while using personal vehicles less. The significant difference between TOD and TAD in both VMT and the number of auto trips means that TOD makes the personal vehicle trips shorter (39% shorter VMT per household) and fewer (35% fewer auto trips per household).

Finally, this study compares travel outcomes among different station area types, and computes household transportation cost using actual travel survey data. Transportation affordability is compared pairwise between TOD, TAD, and hybrid types. Only TAD-TOD pairs show a marginally significant difference in the percentage of household income spent on transportation. This result shows that when a household moves from a TAD to a TOD area, or an existing TAD-type station area becomes TOD, the household is likely to save enough money on vehicle ownership and maintenance costs that, while it spends more on transit, the final result is a significant financial savings on transportation.

This study could have practical implications in station-area planning. The result shows that the numbers of auto trips, transit trips, and walk trips are slightly different between TAD and Hybrid areas, and that the numbers of auto and walk trips are significantly different between TOD and Hybrid. Thus, when a local government or transit authority develops a sprawled, single-use, and unwalkable TAD-type station area into a Hybrid type — by, for instance, adding different land uses — it could expect small increases in transit and walk trips. Then a Hybrid type of station area could be changed into a TOD type through either infill or new developments by adding density and decreasing block sizes, which would result in less driving and more walking by the residents. Then the cumulative change from TAD to TOD could encourage its residents to drive shorter and less, walk more, and take transit more, which would have positive impacts on the city’s environment, society, and economy.

1.0 INTRODUCTION

Transportation has increased from the sixth-largest expenditure (less than 2%) of U.S. household budgets in 1917 to the second-largest since the 1970s (17% in 2014; U.S. Bureau of Labor Statistics, 2014). In recent decades, transit-oriented development (TOD) has gained popularity worldwide as a sustainable form of urbanism; it concentrates developments near a transit station so as to minimize auto-dependency and maximize ridership. A TOD project should give people more transportation options and thereby decrease their transportation cost.

Much of the literature verifies that TODs enhance the use of public transit and reduce car usage (Cervero, 1993, 2004; Langlois et al., 2015; Nasri and Zhang, 2014; Olaru and Curtis, 2015; Venigalla and Faghri, 2015). Existing TOD studies, however, have limits: 1) limited number of study sites, 2) lack of a systematic method to distinguish TOD from other types of station area, and 3) no control for the impact of residential self-selection on travel behavior. There are many exceptions to the above limitations (for a recent robust study dealing with the first two, see Renne et al., 2016), but no study overcomes all three limitations. As a result, it is hard to generalize the findings from the literature to other regions. Also, researchers and planners might not agree with TOD classification in certain studies, which limits the practical implication for transit officials and planners. Finally, when it fails to control for self-selection, the result might overestimate the impact of TOD urban form on travel behavior.

Thus, this study has three research questions. First, how can we distinguish between a transit-oriented development (TOD) and a transit-adjacent development (TAD)? Second, how do travel behaviors vary between TODs and TADs? Third, how does transportation affordability vary between TODs and TADs? To answer these questions, we utilize cluster analysis to classify station area types and propensity score matching to control for residential self-selection. For better generalizability, the data are collected from household travel surveys in eight urban areas across the U.S. with exact XY coordinates for households and trip ends, and household-level measurements of travel activities such as automobile, transit and walk trips. These measures are taken because this study seeks to isolate the impact of living in TOD—or another type of station area—on travel behavior.

There is broad interest in the planning and policy communities for accurate tools that predict the consequences of TOD on the generation of transit ridership and reduction of automobile usage. Our analysis will help guide transportation planners and decision-makers to evaluate or model TOD projects for the promotion of sustainable travel behavior and subsequent economic, social, and environmental impacts.

2.0 LITERATURE REVIEW

2.1 TOD/TAD CLASSIFICATION

Bernick and Cervero (1997, p.5) define transit-oriented development (TOD) as "a compact, mixed-use community, centered around a transit station that, by design, invites residents, workers, and shoppers to drive their cars less and ride mass transit more." Kamruzzaman et al. (2015) state that TOD is a neighborhood that is served by public transit services and offers amenities such as density; walkable, well-connected street patterns; and diversified land uses. Transit-adjacent development (TAD) is often defined by characteristics that show how it fails to be a TOD. A TAD is a noncompact, segregated neighborhood development that calls for auto use instead of inviting walk trips (Belzer and Autler, 2002; Cervero and Duncan, 2002; Dittmar and Ohland, 2004). Halbur (2007) specifies that its lack of a connected street pattern and diverse land use makes a TAD an "evil twin" of a TOD. This study defines TOD as any dense, mixed-use, and walkable area around a transit station, and TAD as any low-density, single-use, and car-dependent station area.

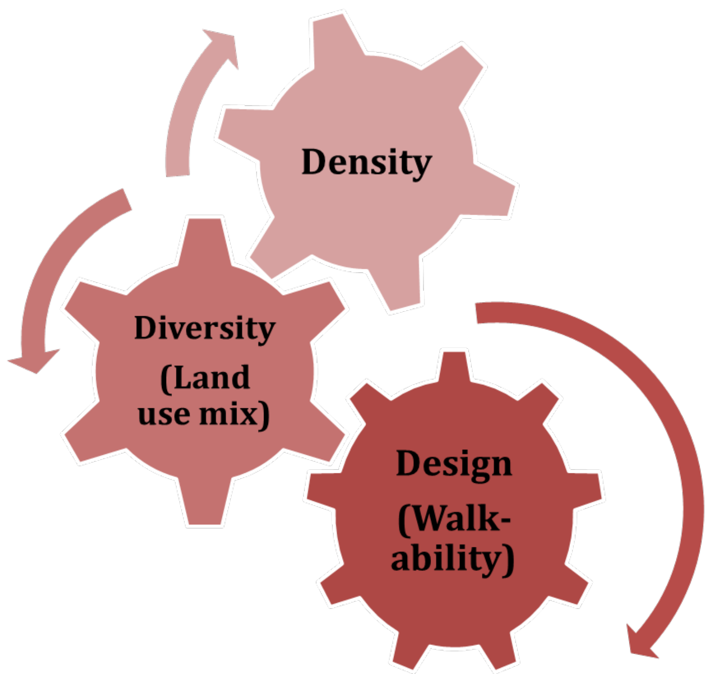


Figure 2-1. Built-Environment Factors of a TOD

The most frequently studied factors for classifying a TOD from other types of station area are residential and employment density (Renne and Ewing, 2013; Kamruzzaman et al., 2015; Laaly, 2014; Pollack et al., 2014; Jeihani et al., 2013; Canepa, 2007; Cervero and Kockelman, 1997; Cervero and Gorham, 1995), land use diversity (Renne and Ewing, 2013; Kamruzzaman et al., 2015; Vale, 2015; Jeihani et al., 2013; Cervero and Kockelman, 1997; Cervero and Gorham, 1995), and walkability or street connectivity (Renne and Ewing, 2013; Vale, 2015; Pollack et al., 2014; Laaly, 2014; Ngo, 2012; Kamruzzaman et al., 2014; Brown and Werner, 2011; Werner, Brown and Gallimore, 2010). Recent studies trying to classify TOD and TAD deal with all three factors in the analysis (Renne and Ewing, 2013; Kamruzzaman et al., 2015; Jeihani et al., 2013).

There are several ways to distinguish TOD from TAD, such as cluster analysis (Kamruzzaman et al., 2015; Vale, 2015) or scoring (Jeihani et al., 2013; Laaly, 2014; Pollack et al., 2014; Renne and Ewing, 2013). As classifying factors, Kamruzzaman et al. (2015) include residential and employment density, public transport accessibility levels (PTALs), land use diversity, and street connectivity levels as measured through intersection density and cul-de-sac density. They then identify five types of station neighborhoods —urban TODs, activity center TODs, potential TODs, TADs, and traditional suburbs. Vale (2015) uses six place-index measurements—residential density, employment density by four sectors, and degree of functional mix—and seven node-index measurements, and then identifies six types of station area—urban TODs, balanced TADs, suburban TODs, undersupplied transit TODs, unbalanced TODs, and future TODs. Using a scoring method, Pollack et al. (2014) divide station areas into four groups—Transit-Oriented, Transit-Supportive, Transit-Related, and Transit-Adjacent.

Existing studies distinguishing TOD from TAD to compare their performance are limited. First, most studies cover only one or a few regions. Although Renne and Ewing (2013) studied 54 regions across the U.S., the outcome variable is not comprehensive travel behavior, but only the percentage of people who commute via public transportation. In contrast, this study includes eight urban areas in various geographic, socioeconomic conditions in the U.S. to examine various travel behaviors using household travel survey data. Second, unlike existing studies relying on straight-line catchment areas (Vale, 2015) or simple scoring systems (Renne and Ewing, 2013), this study utilizes network distance from each station, and cluster analysis. Finally, while Kamruzzaman et al. (2015) establish a robust method of classification, their study analyzes all neighborhoods in a city, Brisbane, Australia. Instead, we use the station-based approach as a focus of TOD and TAD because we deal with the built environments of station areas and their impact on travel behavior, which has more direct implications for planning practice.

2.2 TOD AND TRAVEL OUTCOMES

The benefits of TOD include promoting active modes of transportation, improving access to opportunities such as job or entertainment, offering alternative mobility options and affordable housing for low-income people, reducing greenhouse gas emissions, and stimulating public and private investments in development and community benefits (Center for Transit-Oriented Development, 2011; Noland et al., 2014). Thus, TOD serves interrelated goals for making communities socially, economically and environmentally more robust and sustainable.

To achieve these goals, a TOD should first create settings that prompt people to drive less and ride public transit more (Cervero, 2004). Among various indicators of performance in a TOD, transportation professionals saw transit ridership as the most important, followed by density, parking indicators, design quality indicators and tax revenue (Renne, 2005). In a book published by the Center for Transit Oriented Development (2010), the authors identified vehicle miles travelled (VMT) as the key performance measure for TOD, expressing their understanding that lower VMT results when people walk, bike, and use transit more, and have more transportation options.

Much of the literature verifies that TODs enhance the use of public transit and reduce car usage (Cervero, 1993, 2004; Langlois et al., 2015; Nasri and Zhang, 2014; Olaru and Curtis, 2015; Venigalla and Faghri, 2015). Based on data from 17 TOD projects, Cervero and Arrington (2008) show that residents living in TOD areas are two to five times more likely to commute by transit than their non-TOD counterparts. Nasri and Zhang (2014) find that people living in TOD areas tend to drive less, reducing their VMT by around 21-38%, compared to the residents of the non-TOD areas even with similar land use pattern in the Baltimore and Washington, D.C., regions. Hale (2014) describes that the mode share by active transportations including transit, walk, and bike accounts for about 50-80% in TOD areas, which is much higher than the 25-40% found in TAD areas. Living in TOD promotes more walking and biking as well. Olaru and Curtis (2015) confirm that better biking and pedestrian infrastructure resulted in more bike and walk trips along with higher transit ridership compared to auto-trips in the TOD precincts.

Cervero (2004) found evidence that many TOD ridership gains were a result of self-selection—individuals who wish to drive less may select homes in transit-oriented environments. Many studies have found associations between attitudes and travel choices as evidence of residential self-selection (Cao, Mokhtarian and Handy, 2009; Mokhtarian and Cao, 2008; Handy, 2004). Thus, individuals' attitudes may confound the relationship between the TOD-type urban form and travel choices, and in turn the effect of the built environment on travel may be overestimated (Ewing, Hamidi and Grace, 2016).

From the review of 38 empirical studies, Cao, Mokhtarian and Handy (2009) seek to control for self-selection bias and examine nine methodological solutions: direct questioning, statistical control, instrumental variables, sample selection, propensity score, joint discrete choice models, structural equations models, mutually dependent discrete choice models, and longitudinal designs. While the authors suggest using longitudinal structural equations modelling with control groups, a propensity score matching (PSM) method is also highly recommended in a nonrandomized observational study, in which it could mimic a randomized experiment using a propensity score (Cao, Mokhtarian and Handy, 2009). The propensity score approach has recently been applied in travel behavior research (Boer et al., 2007; Cao, 2010; Cao, Xu and Fan, 2010; Cao and Fan, 2012; Cao and Schoner, 2014), but not yet in the context of station areas. Detailed explanation of the PSM will be presented in the Research Design section.

2.3 TRANSPORTATION AFFORDABILITY

Transportation is the second-biggest expense, after housing, for the majority of American families (Lipman, 2006). However, transportation cost has not garnered as much attention as housing affordability in policy interventions and research until very recently (Agrawal et al., 2011, Rice, 2004). For many years, commuting expenditures were not even included in the transportation calculation (Mattingly and Morrissey, 2014). This made it easier to justify the expansion and creation of more urban sprawl — overlooking the influence of housing location in total household expenditures highlights the lower prices of housing on the urban fringe and fosters sprawl development (Dawkins, 2009; Quigley and Raphael, 2005; Glaeser and Gyourko, 2003; Burchell et al., 2000). Further, it does not take into consideration the costs of automobile dependency, vehicle maintenance and fuel for commuting to distant suburbs (Newman and Kenworthy, 1989; Anderson, Kanaroglou and Miller, 1996; Horner, 2002; Low et al., 2005). The tension between the negative environmental impacts and the housing affordability that come with urban sprawl would be better balanced by carefully including in calculations the transportation costs associated with different housing locations (Kellett, Morrissey and Karuppannan, 2012).

To understand the comprehensive cost of commuting, one must focus on transportation affordability. Here, the purpose is to identify the financial burden of the combined housing and transportation expenditures incurred by travelers. Although different affordability measures have been identified, they remain inadequate to grasp the pattern of the commuting cost and the comprehensive concept of transportation affordability (Hamidi, Ewing and Renne, 2016; Mattingly and Morrissey, 2014). Therefore, inconvenient economic realities of suburban life were almost overlooked. The pre-recession swing of financial downturns that increased fuel costs and foreclosures also consumed the lion's share of income for those living in the urban fringe (Hamidi, Ewing and Renne, 2016). Thus, Lipman (2006) showed that 29% of household incomes were spent on transportation as opposed to 28% on housing in 28 metropolitan suburbs in a 2006 study. Transportation costs, it should be understood when crafting equitable transportation policies to create affordable mobility for all types of households, are more burdensome for the poor (Agrawal et al., 2011, Jewkes and Delgadillo, 2010, Rice, 2004).

In traditional studies, transportation affordability is measured with respect to household income in order to reflect the financial ability of the different income groups (Haas et al., 2008; Hickey et al., 2012; Sanchez and Brenman, 2007). Then the transportation cost is measured from three components of travel behavior—auto ownership, auto use, and transit use—with each of these modeled outputs weighted by a cost per unit (Haas et al., 2008; Hickey et al., 2012). Haas et al. (2008) estimate that average annual transportation cost over household income is 20.1% for median-income households in the U.S. From the 25 largest metro areas, Hickey et al. (2012) found that share of income spent on transportation for moderate-income households is from 21% to 35% in different regions. Haas et al. (2013) further find that variation in household transportation cost is related more strongly to the characteristics of a neighborhood than the household. On the other hand, Fan and Huang (2011) criticize the traditional measures that focus on the proportion of household income consumed by transportation-related expenditures because these often fail to consider the wide variation in households' transportation needs and locational settings.

On the relationship between housing location and transportation costs, the literature shows that households in areas with high accessibility to job locations save significantly on transportation (Bajic, 1983; Gibbons and Machin, 2005; and So, Tse and Ganesan, 1997). An Australian study (Dodson and Sipe, 2008) about commuting expenditures with respect to housing location shows that as oil prices rise, suburbanites encounter higher financial risk since they depend on private vehicles for everyday commutes. Corroborating such findings, Viggers and Howden-Chapman (2011) report that living in relatively inaccessible suburban locations can pose risk to homeowners' financial sustainability. They specifically identify the lack of public transit and the longer commuting distances as factors causing such financial instability. Currie and Senbergs

(2007) report similar findings and also that households owned more vehicles in low-density suburbs than in the high-density central parts of a city. They also find lack of accessibility and viable public transit ultimately added to the financial challenges of the residents. In comparison, Hamidi, Ewing and Renne (2016) show that as urban areas become more compact and dense, transportation costs decrease, lowering overall household expenditures.

3.0 RESEARCH DESIGN

3.1 STUDY REGIONS

This study includes eight urban areas meeting two criteria. First, we have a household travel survey data with XY coordinates for households and trip ends. Second, the region had a rail-based transit system of some sort before its survey was conducted. In the eight regions (Table 3-1), the household travel surveys were conducted between 2006 and 2012, and we found 549 rail-based transit stations from the national TOD Database (Center for Transit Oriented Development, http://toddata.cnt.org). Transit types include heavy rail (109 stations), commuter rail (148 stations), and light rail (272 stations). Boston had the most stations (n=239), followed by Portland (n=94) and Miami (n=50), and Minneapolis-St. Paul had the fewest (n=20).

Table 3-1: Study regions and transit stations[1]

No	Region	Year (survey)	Heavy rail	Commuter rail	Light rail	Total	Sample households (½ mile)
1	Atlanta, GA	2011	38	0	0	38	138
2	Boston, MA	2011	49	121	72	239[2]	1,586
3	Denver, CO	2010	0	0	36	36	152
4	Miami, FL	2009	22	4	24[3]	50	26
5	Minneapolis-St. Paul, MN	2010	0	4	16	20	97
6	Portland, OR	2011	0	7	87	94	304
7	Salt Lake City, UT	2012	0	1	36	37	114
8	Seattle, WA	2006	0	11	25	35[2]	16
	Total		109	148	272	549	2,433

1) This study includes only transit stations that had opened before the survey year.
2) The total stations is not equal to the sum of each row because some stations serve two or more types of transit.
3) Miami's People Mover, an automated guideway transit, is included under the LRT category.

3.2 DATA

Following the definition of TOD and the literature review, this study classifies station areas by activity density, land use diversity and walkability. Activity density is the sum of population and employment for traffic analysis zones (TAZs), acquired from regional MPO data, divided by gross land area (Ewing et al., 2015). For land use diversity, we computed an entropy index. Each region provided parcel maps so that we could calculate the proportion of the area of each land use type—residential, commercial, and public—in a half-mile buffer from each station. For the “walkability” variable, we computed the number of intersections per square mile from street network shapefiles. Because these three built-environment variables—activity density, land use entropy, and intersection density—vary in range, we scaled the data by standardizing each variable to a mean of 0 and a standard deviation of 1.

Although distance to transit is not included as a classifying factor, we measured it as a network distance from a household to the rail station because that might be an important determinant of transit trips. Also, regional accessibility is another important variable to predict travel behaviors (Ewing et al., 2015). The regional accessibility to employment is the percentage of jobs that could be reached within 10 minutes by automobile, which tends to be highest at central locations and lowest at peripheral ones. We used travel time skims and TAZ-level employment data acquired from regional MPOs.

From the travel survey data in eight regions, we calculated automobile trips, vehicle miles traveled (VMT), transit trips, and walk trips by individual households. The survey data have exact XY coordinates so the researchers could geocode the precise locations of residences and measure the lengths of trips, although the use of the minimum possible path between two trip ends might underestimate the exact VMT of the trips travelers actually take (Ewing, Hamidi and Grace, 2016). The survey data include demographic variables such as household size, the number of employed, household income, and the number of personal vehicles per person. The number of households living within a half-mile of stations and included in the household travel surveys was 2,433 in the eight regions.

3.3 RESEARCH PROCESS AND METHODS

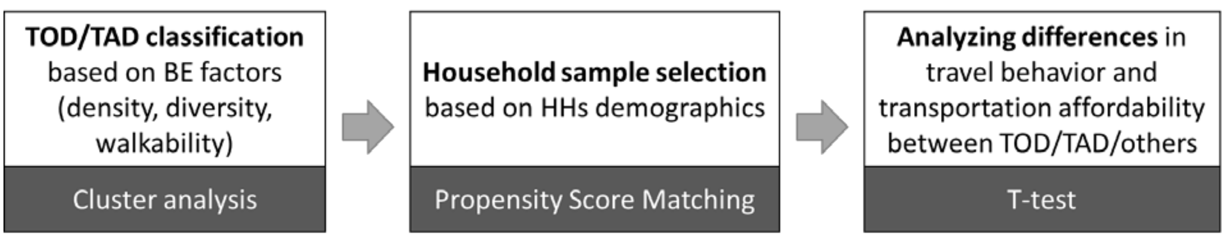


Figure 3-1. Research process of this study

This study consists of three steps. Although detailed explanations of each step will be followed, we present the whole picture here briefly. First, we classify station areas based on three built-environment characteristics—density, diversity, and walkability—as the literature suggests. Second, from the household travel surveys, we select household samples living in each type of station area. As the households could be significantly different among station area types and it could make it hard to evaluate the true impact of built environment on travel behavior, this study utilizes propensity score matching method in order to make samples comparable and thus, control residential self-selection. Finally, this study compares travel outcomes among different station area types, and computes household transportation cost using actual travel survey data. The transportation affordability is compared among TOD, TAD and other types.

3.3.1 Step 1. TOD/TAD classification: Cluster analysis

Because the built environments around transit stations fall within a TOD-TAD spectrum, not a simple dichotomous scale, and there is no certain agreement of ideal built environments for TOD, identifying TODs and distinguishing them from TADs could be a difficult but important research step. Cluster analysis has been a preferred method for generating TOD typologies in previous studies (Atkinson-Palombo and Kuby, 2011; Kamruzzaman et al., 2014; Vale, 2015).

Using cluster analysis, this study classifies station area types based on three built-environment factors—density, land use diversity, and walkability. This approach groups existing station areas based on the actual characteristics of their built environments, rather than theoretical criteria of TOD or TAD. To be specific, this study uses a hierarchical clustering algorithm with Ward D2 distance measure. To determine the optimal number of clusters in a data set, this study utilizes the "NbClust" package in R 3.3.1 software, which provides 26 validation indices of clustering, such as the Calinski and Harabasz index and the Silhouette index (Charrad et al., 2014).

3.3.2 Step 2. Household sample selection: Propensity score matching

Propensity score matching (PSM) has been widely used to overcome nonrandom assignment of treatment in the evaluation of social programs (Oakes and Johnson, 2006). Evaluation studies are often based on observational data, in which the assignment of treatment is not random. Accordingly, individuals in the treatment group are likely to differ systematically from those in the control group. For example, households living in suburban regions could be more affluent than their counterparts in downtown, a result of residential self-selection. Therefore, observations of difference in behavioral outcomes between the groups are confounded by residential self-selection. Statistically, it generates a biased estimate of treatment effect.

The propensity score is defined as the conditional probability of assignment to a particular treatment given a vector of observed covariates (Rosenbaum and Rubin, 1984). In the context of TOD and TAD, the treated group is households living in TOD station areas while the control group is those living in either TAD or Hybrid areas.

The propensity score matching was implemented in R 3.3.1 using the MatchIt package. First, we develop a binary logit model to estimate a propensity score using the subsample of households living in TOD (treatment) and TAD (control). We chose household characteristics as independent variables—household size, the number of workers, household income, distance to the nearest transit station, regional job accessibility, and the regions—as potential sources of residential self-selection and confounding factors in travel outcome. Because the PSM model is a prediction model, we do not need to check the statistical significance and multicollinearity of independent variables (Cao, Xu and Fan, 2010). Second, we match each household living in TODs with those in TADs based on the propensity score. A caliper length of 0.2 is used for matching as suggested by Austin (2009), meaning that for a treatment observation, we seek a match in control observations whose propensity scores are within 0.2 of the standard deviation of the score in the treatment observation. Third, we evaluate whether the TOD residents are systematically different from their matches in TADs. If they are different in terms of demographics, self-selection is still a concern. We use t-test to assess whether demographics and locational factors are balanced between the matched groups.

The final goal of PSM is to compute the “true” impact of TOD/TAD on travel behavior. Once the matching was complete, we calculated the average treatment effects (ATE) of station area type on VMT, transit trips, and walk trips. For the illustration example below, the ATE is computed as the mean travel factors of the matched TOD households minus those of the matched TAD households. The observed influence of living in TOD on travel behavior is same calculation but using the original samples in TOD and TAD before matching (see Figure 3-2). The ratio of ATE over the observed influence is the proportion of the observed difference that can be attributable to TOD/TAD itself.

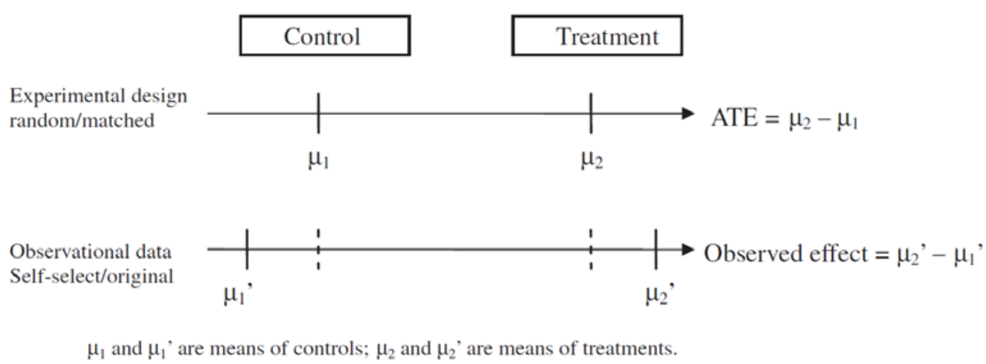


Figure 3-2. The relationship between observed effect and treatment effect (Cao, Xu and Fan, 2010)

Because this study has three area types—TOD, TAD and Hybrid—in contrast to most studies with only one treatment and one control, this study applies PSM with multiple nominal treatments (Lechner, 2002). In this case, the propensity score can be estimated separately for each control-treatment pair. For each pair of locations, we estimated a binary logit model using the subsample containing respondents living in the locations.

3.3.3 Step 3. Analysis of transportation affordability

In this study, we estimate household transportation costs as the sum of vehicle costs (household’s expenses to own and use private vehicles) and public transit costs (transit fares). Vehicle costs are divided into fixed and variable costs.

$$\text{Household Transportation Costs} = C_{AO} \times F_{AO}(X) + C_{AU} \times F_{AU}(X) + C_{TU} \times F_{TU}(X)$$

where C is a cost factor (i.e., dollars per mile) and F is a function of the independent variables ($F_{AO}$is auto ownership, F_{AU} is auto use, and F_{TU} is transit use). Fixed or ownership costs are not generally affected by the amount a vehicle is driven. Depreciation, insurance, and registration fees are considered fixed. Variable costs are the incremental costs that increase with vehicle mileage. Fuel is a variable vehicle cost; it is proportional to mileage (Lipman, 2006).

We computed vehicle fixed costs based on our household vehicle ownership data and the average cost of car ownership specific to the most popular cars for each income bracket. Our average car ownership costs are based on the "True Cost to Own (TCO) pricing" system developed by Edmunds Inc. The components of TCO are depreciation, interest on financing, taxes and fees, insurance premiums, fuel, maintenance, repairs and any federal tax credit. In this study, we used all categories except fuel because we treat fuel as a variable vehicle cost.

We were interested in costs for the most popular vehicles' model and make for specific income levels. First, we selected all surveyed households in eight study regions from the National Household Travel Database (NHTS) and identified the 10 most popular vehicles for each of 18 income brackets classified by HUD (For the lowest and highest income brackets, see Table 3-2). Because TCO calculated the costs for cars made after 2009, the most similar model with the lowest edition was taken for older models. These popular vehicles account for about 30% of total vehicles in the eight regions in the NHTS database. While the average vehicle ownership cost moderately increases with income level, the difference is not huge. It is $4,278 for the lowest income group and $4,464 for the highest income group. Then this fixed cost per car for each income group is multiplied by the number of cars owned by a household in our travel survey data.

Table 3-2. Top 10 automobiles and average ownership cost for lowest and highest income bracket in eight regions from NHTS and Edmunds Inc. data

	Make name	Model name	Annual Ownership Cost (except fuel cost)	Sample size	Average Own Cost (weighted by sample %)
Lowest income bracket **(median annual income = $2,500)**	Ford	F-Series pickup	$4,570	14	**$4,278**
	Chevrolet	C, K, R, V-Series pickup/Silverado	$5,243	11	
	Ford	Range Supercab	$3,923	10	
	Toyota	Camry	$3,470	7	
	Dodge	Caravan/Grand Caravan	$3,787	6 (tie)	
	Ford	Bronco/Explorer Sport Trac	$5,297	6	
	Buick	Century/Buick Regal	$3,989	6	
	Chevrolet	Cavalier	$3,096	6	
	Jeep	Cherokee	$5,121	6	
	Ford	Taurus/Taurus X	$4,522	5 (tie)	
	Ford	Maverick	$3,051	5	
Highest income bracket **(median annual income = over $100,000)**	Ford	F-Series pickup	$4,570	220	**$4,464**
	Chevrolet	C, K, R, V-Series pickup/Silverado	$5,243	124	
	Honda	Accord	$3,892	105	
	Toyota	Camry	$3,470	89	

Honda	Odyssey	$4,059	74
Ford	Bronco/Explorer Sport Trac	$5,297	71
Jeep	Cherokee	$5,121	64
Honda	Civic/CRX, del Sol	$3,111	60 (tie)
Ford	Expedition	$5,745	60
Dodge	Ram Pickup	$4,418	51 (tie)
Toyota	Tacoma	$3,767	51

Second, we computed auto operating costs based on our household VMT data and gasoline price data specific to eight metropolitan regions. As illustrated in Table 3-3, average gasoline prices vary from region to region. We acquired metropolitan-level average gasoline prices for regular unleaded in 2010 from the Oil Price Information Service (OPIS) and then multiplied the fuel costs per gallon by the actual VMT to obtain the household's operating or variable vehicle costs.

Table 3-3. Average gasoline price per gallon (2010) for eight regions

Region	Gas Price ($/gallon)
Atlanta, GA	2.83
Boston, MA	2.89
Denver, CO	2.75
Miami, FL	3.01
Minneapolis-St. Paul, MN	2.83
Portland, OR	3.02
Salt Lake City, UT	2.94
Seattle, WA	3.15

Third, we compute transit costs based on our household transit trip data and average transit fares specific to the regions (Table 3-4). Transit fare data come from the National Transit Database. We computed average transit fare for each region by dividing the total transit revenue by total number of unlinked passenger trips for the region. We multiplied the amount of fare per transit trip by the actual number of transit trips to obtain the household's public transit costs.

Table 3-4. Average transit fare (2010) for eight regions

Region	Transit fare ($)
Atlanta, GA	0.82
Boston, MA	1.26
Denver, CO	1.03
Miami, FL	0.96
Minneapolis-St. Paul, MN	1.14
Portland, OR	0.93

Salt Lake City, UT	0.92
Seattle, WA	1.37

To estimate the overall household's transportation costs for each property in our sample, we added up the three transportation cost components. Finally, we calculated the percentage of a household's income spent on transportation—i.e. transportation affordability—for sample households in each station area type.

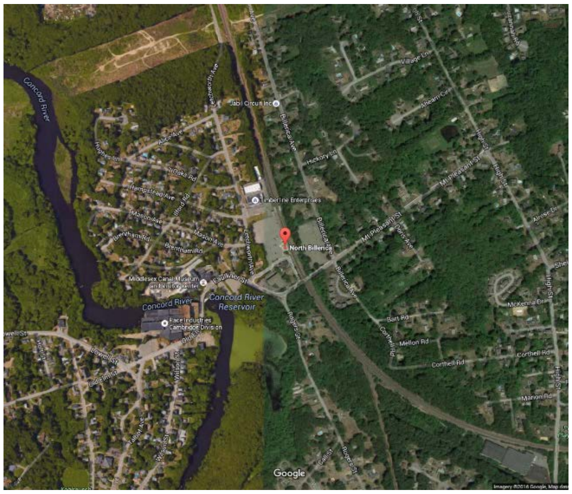
4.0 TOD/TAD CLASSIFICATION: CLUSTER ANALYSIS

By using the NbClust package in R 3.3.1 software, which generates 26 validation indices of clustering, this study could determine the optimal number of clusters in the data set. As a result, thirteen of the 26 indices suggest that three is the optional number of clusters.

Table 4-1 shows the result of hierarchical clustering. The first cluster (n=107) is titled "TAD." It has the lowest levels of activity density, land use diversity and intersection density. The second and largest cluster (n=382), "Hybrid," has low levels of activity density and intersection density, but the highest land use entropy index. The final cluster (n=60), "TOD," has the highest activity density and intersection density, and a high level of land use mix. Figure 4-1 shows representative stations in each cluster. The stations are selected for values closest to the median on each of the three classifying factors.

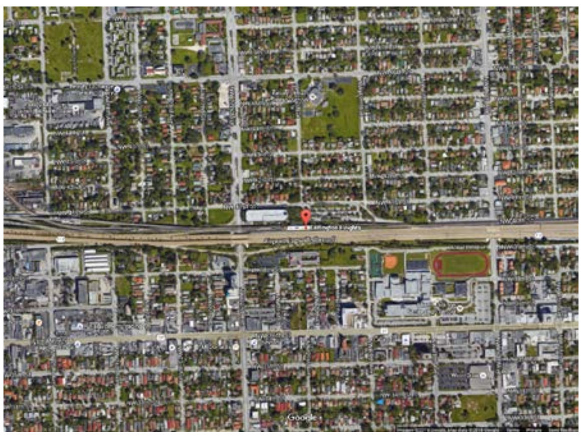
Table 4-1. Cluster analysis result and descriptive statistics

Cluster type	Number of Stations	Activity Density (/sq.mi.)		Entropy Index		Intersection Density (/sq.mi.)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
TAD	107	10,319	11,751	0.30	0.19	110	58
Hybrid	382	21,210	19,764	0.75	0.15	194	79
TOD	60	135,327	51,025	0.70	0.24	386	110
TOTAL	**549**	**31,559**	**43,821**	**0.66**	**0.24**	**199**	**108**



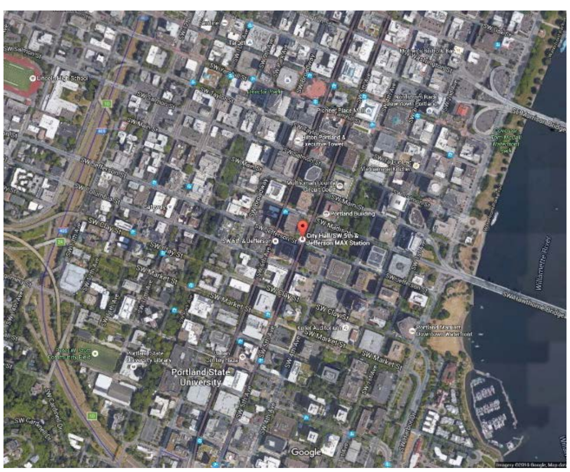
1) TAD type: North Billerica Station, Boston

- Population (½ mile): 548
- Employment (½ mile): 420
- Activity Density: 2,384/sq. mi.
- Land Use Entropy: 0.30
- Residential 55%, Commercial 1%, Public 3%
- Intersection density: 118/sq. mi.
- Transit Stop density: 7/sq. mi.



2) Hybrid type: Earlington Heights Station, Miami

- Population (½ mile): 2,965
- Employment (½ mile): 1,205
- Activity Density: 11,003/sq. mi.
- Land Use Entropy: 0.78
- Residential 53%, Commercial 9%, Public 19%
- Intersection density: 198/sq. mi.
- Transit Stop density: 74/sq. mi.



3) TOD type: City Hall/SW 5th Ave. and Jefferson St. MAX Station, Portland

- Population (½ mile): 7,412
- Employment (½ mile): 43,614
- Activity Density: 112,145/sq. mi.
- Land Use Entropy: 0.71
- Residential 14%, Commercial 62%, Public 10%
- Intersection density: 393/sq. mi.
- Transit Stop density: 705/sq. mi.

Figure 4-1. Examples of each station area type (Image Source: Google Maps)

Sample households were selected as those living within a half-mile, network distance, from stations. We allotted individual households to their nearest stations based on network distance in order to assign the station types. TAD type has 251 sample households while TOD and Hybrid type have 306 and 1,876 households, respectively (Table 4-2).

Table 4-2 shows that households living in TADs have more household members, more employed members, and higher incomes than those living in TODs or Hybrids. ANOVA analysis shows that the differences are significant. Regarding travel behavior, TAD households have much higher VMT and daily auto trips, and lower daily transit and walk trips, than those in TODs or Hybrids. The average Hybrid-area household is in the middle on five of the seven measurements, the exceptions being their low household incomes and high number of transit trips. Personal vehicle travel accounts for two-thirds of total trips in TADs but only a quarter of total trips in TODs (Figure 4-2).

Post-hoc comparisons using Tukey's Honest Significant Difference (HSD) method show that the three groups are significantly different from each other in VMT, auto trips, and walk trips variables. TAD and Hybrid show no significant difference in household size and worker variables, while TOD and Hybrid are similar in terms of transit trips (Table 4-2).

Table 4-2. Household characteristics and travel behavior by station area types: average and ANOVA analysis

Cluster type	**No. of Stations**	**HH samples**	**HH size**	**HH workers**	**HH Income ($1,000) (2010)**	**VMT**	**Daily Auto Trips**	**Daily Transit Trips**	**Daily Walk Trips**
TAD	107	251	2.19	1.28	83.72	21.23	6.06	0.72	1.91
Hybrid	382	1,876	2.15	1.22	77.02	15.44	4.93	1.47	3.89
TOD	60	306	1.54	0.97	82.02	8.61	2.04	1.35	4.81
Total	**549**	**2,433**	**2.07**	**1.19**	**78.34**	**15.18**	**4.68**	**1.37**	**3.80**
F-statistic (ANOVA)	-	-	37.23 ***	14.1 ***	2.37 *	32.00 ***	47.19 ***	12.42 ***	30.37 ***
Different pairs (post-hoc test)	-	-	TOD-TAD; TOD-Hybrid	TOD-TAD; TOD-Hybrid	none	all	all	TOD-TAD; TAD-Hybrid	all

***: p<.01, **: p<.5, *: p<.1

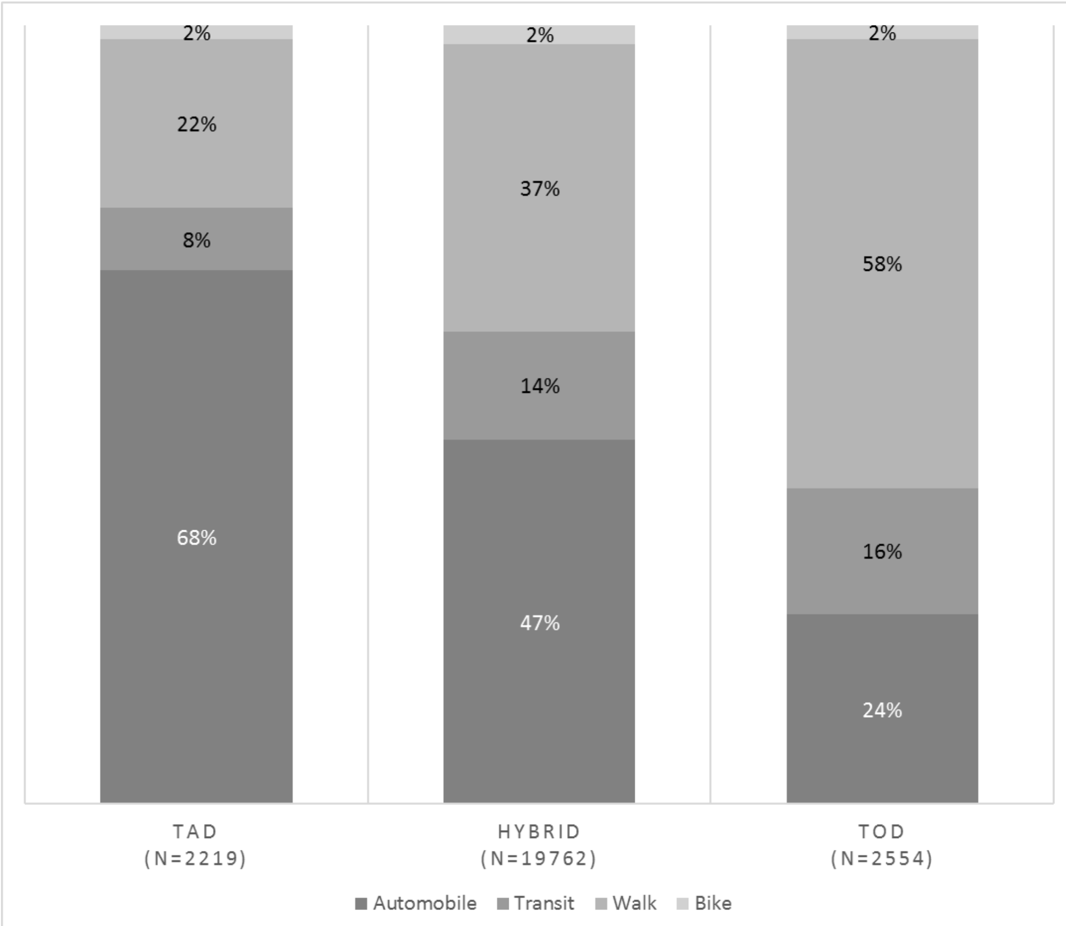


Figure 4-2. Mode Share by Station Area Type (n is total number of trips in each area type)

5.0 TRAVEL BEHAVIOR IN TOD VS. TAD HOUSEHOLDS: PROPENSITY SCORE MATCHING

As shown above, in the context of station areas, households living in TADs tend to be more affluent, have more cars, have more members, and be more auto-oriented than their counterparts in TODs. Residential self-selection theory says, however, that the TAD households might live there because they are auto-oriented. Therefore, the true difference in travel outcomes between TODs and TADs is estimated here by matching samples using PSM.

With the six explanatory variables—household size, the number of workers, household income, distance to nearest transit station, regional job accessibility, and the regions, household pairs in three area-type pairs (TOD-TAD, TOD-Hybrid, and TAD-Hybrid) are matched. The PSM generates 54 household pairs (108 households total) in TOD-TAD, 175 pairs in TOD-Hybrid and 182 pairs in TAD-Hybrid.

After matching, we first evaluate whether the chosen residents in one type are systematically different from those in another type. If they are different in terms of demographics, self-selection is still a concern. Table 5-1 shows differences of household characteristics before and after matching. Unlike for unmatched samples, t-test results for matched samples show that TOD and TAD residents do not differ by all covariates. Those variables are not statistically different in both TOD-Hybrid and TAD-Hybrid pairs as well (results are not shown).

Table 5-1. Mean differences of observed covariates between TOD and TAD in unmatched and matched samples

Variables		Before Matching			After Matching		
		TAD (n=251)	TOD (n=306)	Mean Difference[1)]	TAD (n=54)	TOD (n=54)	Mean difference[1]
Household size		2.19	1.54	0.65***	1.50	1.52	-0.02
Household workers		1.28	0.97	0.31***	1.04	1.02	0.02
Household income ($1,000)		83.72	82.02	1.70	72.19	76.34	-4.15
Distance to station (miles)		0.33	0.28	0.05***	0.32	0.33	-0.01
Regional job accessibility		9.89	19.04	-9.15***	15.98	16.76	-0.78
Number of Station Areas by Region[2]	Atlanta	32	12	-	10	9	-
	Boston	75	204	-	7	9	-
	Denver	40	29	-	17	18	-
	Minneapolis	67	23	-	17	14	-
	Portland	31	38	-	3	4	-

1) ***: p<.01, **: p<.5, *: p<.1 (T-test results)

2) Miami, Salt Lake City, and Seattle are dropped because no matched samples were found.

The final goal of PSM is to compute the “true” impact of station area type on travel behavior. Once the matching was complete, we calculated the average treatment effects (ATE), the observed differences, and the ratio between them on VMT, auto trips, transit trips and walk trips for each area pair. As an example, the observed difference of the TOD-TAD pair is the mean travel factors of all TOD households minus that of all TAD households in the original sample. The ATE is the difference in mean travel factors between the matched samples.

In Table 5-2, the third to seventh columns show, respectively, observed difference in mean in the original sample, ATE in matched sample, ratio of ATE over observed difference, mean value of control group after matching (the control group is TAD in the first and third pair and Hybrid in the second pair), and ratio of ATE over control mean. Regarding VMT in TOD-TAD pairs, after matching (i.e., controlling for residential self-selection), TAD households tend to drive 5.49 miles per day more than TOD residents. The significant effect on VMT of living in a TOD accounts for approximately 87% of the observed influence; that is, 13% of the observed difference may result from residential self-selection.

In addition, the mean difference in daily automobile trips between matched TAD and TOD households is 1.44 and statistically significant. That is, if a randomly selected household moves from a TAD to a TOD, we expect a decrease in driving by 1.44 trips per day. The effect on auto trips of living in TOD accounts for approximately 36% of the observed influence, meaning that the rest 64% may result from unobserved factors such as self-selection. On average, the matched sample households in TAD drove 4.06 times per day. Thus, the effect of living in TOD itself represents a considerable 35% decrease (1.44 fewer trips) in daily auto trips.

In addition, the probability of walking or taking transit significantly decreases from TOD to TAD. After matching, an average household living in a TOD takes 0.74 more transit trips (a 148% increase) than its pair in a TAD. Likewise, the average household in a TOD takes 1.89 more walk trips (a 110% increase) than its pair in a TAD, and both differences are statistically significant.

When we compare Hybrid areas to TODs, the number of daily auto trips is significantly higher (0.84 more) and the number of walk trips is significantly lower (1.20 fewer) in Hybrid areas. The effect of living in TOD itself represents a 27% decrease in daily auto trips and a 30% increase in daily walk trips, compared to living in a Hybrid area. VMT and transit trips are not significantly different between Hybrid and TOD areas.

In the TAD-Hybrid pair, auto trips are not significantly different. Differences on VMT, walk trips, and transit trips are slightly significant. Compared to TAD areas, VMT is lower (3.75 fewer miles), the number of daily transit trips is higher (0.35 more), and the number of daily walk trips is higher (0.75 more) in Hybrid areas. The effect of living in a Hybrid area itself represents a 16% decrease in VMT, a 48% increase in transit trips, and a 36% increase in walk trips, compared to living in a TAD.

Table 5-2. Differences in travel behavior between station area types after matching

Area Type Pair	Travel outcomes	Observed difference (original sample)	ATE (difference after matching)	ATE/observed difference ratio	Mean of Control Group	ATE/ control ratio
TAD (control) – TOD n=557 (unmatched), n=108 (matched)	VMT	6.34***	5.49**	0.87	14.18	0.39
	Auto trips	4.02***	1.44**	0.36	4.06	0.35
	Transit trips	-0.64***	-0.74***	1.16	0.50	-1.48
	Walk trips	-2.86***	-1.89***	0.66	1.72	-1.10
Hybrid (control) – TOD n=2,182 (unmatched), n=350 (matched)	VMT	3.64***	0.48	0.13	9.53	0.05
	Auto trips	2.87***	0.84**	0.29	3.10	0.27
	Transit trips	0.11	-0.12	-1.09	1.39	-0.09
	Walk trips	-0.89***	-1.20***	1.35	3.95	-0.30
TAD (control) –Hybrid n=2,127 (unmatched), n=364 (matched)	VMT	2.70**	3.75*	1.39	23.69	0.16
	Auto trips	1.15***	0.00	0.00	6.70	0.00
	Transit trips	-0.75***	-0.35*	0.47	0.73	-0.48
	Walk trips	-1.97***	-0.75*	2.08	2.08	-0.36

***: p<.01, **: p<.5, *: p<.1 (paired T-test results)

From the results of travel outcomes between three pairs of station area type, we could examine the gradual and cumulative changes. When a household moves from a TAD type to a Hybrid type, or a local government improves a TAD to a Hybrid by increasing its density, land use mix, or walkability, the average household is expected to have slightly shorter auto trips and more walk trips and transit trips. Then, if the household moves to a TOD, or the station area is developed to a TOD, the household is expected to have fewer auto trips and more walk trips. Cumulatively, from a TAD to a TOD, a household is estimated to have significantly shorter and fewer auto trips and more transit and walk trips.

6.0 TRANSPORTATION AFFORDABILITY IN TOD VS. TAD HOUSEHOLDS

Household transportation costs consist of three components of travel behavior—vehicle ownership, vehicle use, and transit use (Haas et al., 2008; Hickey et al., 2012). From the original data before matching, the average income is $78,341 (table 6-1). The average household spends $4,532 for vehicle ownership, $747 for vehicle use, and $600 for transit use. Thus, total transportation cost is $5,879 for the average household, which is 12.5% of yearly household income. Yearly transportation costs vary from $4,217 in TOD areas to $6,411 in TAD areas, with a gap of $2,194. Likewise, transportation affordability percentages range from 8.6% in TOD to 13.3% in Hybrid. Hybrid type is least affordable as it has lowest average household income. All of the differences in transportation cost and affordability are statistically significant.

The overall transportation cost in this study is much smaller than in previous studies. Haas et al. (2008), for example, estimate that the average percentage of household income spent on transportation is 20.1% for median-income households in the U.S. This difference might be mainly attributable to the fact that this study deals only with station areas while the previous studies cover entire metro areas.

Table 6-1. Differences in transportation cost and affordability before matching (n=2,433)

Type	Income	Vehicle Ownership cost	Vehicle Use cost	Transit cost	Total Transportation cost	Transportation Affordability
TAD (n=251)	$83,717	$5,096	$1,033	$282	$6,411	11.4%
TOD (n=306)	$82,023	$3,218	$422	$577	$4,217	8.6%
Hybrid (n=1,876)	$77,021	$4,670	$762	$647	$6,078	13.3%
Average	$78,341*	$4,532***	$747***	$600***	$5,879***	12.5%***

***: p<.01, **: p<.5, *: p<.1 (ANOVA test results)

After matching, the difference in transportation affordability between TAD and TOD areas is slightly significant (Table 6-2). Average TAD households spend 15.6% after matching while average TOD households spend less than half of that—7.5%. Higher spending on transit in TOD is cancelled out by lower spending on vehicle ownership and maintenance. Overall, matched households in both types spend about five thousand dollars a year for transportation, which accounts for 11.5% of income.

Table 6-2. Differences in transportation cost and affordability after matching: TOD-TAD pairs (n=108)

Type	Income	Vehicle Ownership cost	Vehicle Use cost	Transit cost	Total Transportation cost	Transportation Affordability
TAD	$72,194	$4,332	$679	$198	$5,209	15.6%
TOD	$76,340	$3,799	$418	$481	$4,697	7.5%
Average	$74,267	$4,065	$548**	$340**	$4,953	11.5%*

***: p<.01, **: p<.5, *: p<.1 (paired T-test results)

On the other hand, in the Hybrid-TOD pair, t-test result shows that neither the transportation cost nor the affordability percentage is significantly different between the two areas (Table 6-3). As a result, matched households in both types spend about $4,168 a year for transportation, which accounts for 9.0% of income.

Table 6-3. Differences in transportation cost and affordability after matching: TOD-Hybrid pairs (n=350)

Type	Income	Vehicle Ownership cost	Vehicle Use cost	Transit cost	Total Transportation cost	Transportation Affordability
Hybrid	$70,144	$2,862	$464	$573	$3,899	9.0%
TOD	$77,994	$3,366	$443	$628	$4,438	8.9%
Average	$74,069	$3,114	$453	$600	$4,168	9.0%

***: p<.01, **: p<.5, *: p<.1 (paired T-test results)

In the TAD-Hybrid pair, only transit spending shows a significant difference, being higher in Hybrid areas (Table 6.4). As a result, matched households in both types spend about seven thousand dollars a year for transportation, which accounts for 12.2% of income.

Table 6-4. Differences in transportation cost and affordability after matching: TAD-Hybrid pairs (n=364)

Type	Income	Vehicle Ownership cost	Vehicle Use cost	Transit cost	Total Transportation cost	Transportation Affordability
TAD	$88,906	$5,688	$1,159	$283	$7,130	11.6%
Hybrid	$82,791	$5,242	$979	$456	$6,677	12.8%
Average	$85,480	$5,465	$1,069	$369**	$6,903	12.2%

***: p<.01, **: p<.5, *: p<.1 (paired T-test results)

Unlike the travel behavior results, transportation affordability has no gradual effects—from TAD to Hybrid or from Hybrid to TOD. Only TAD-TOD pairs show a marginally significant difference in the percentage of household income spent on transportation. This result shows that when a household moves from a TAD to a TOD, or an existing TAD-type station area becomes a TOD, the household is likely to save money on vehicle ownership and use while spending more on transit, which balances out to significant financial savings on transportation.

7.0 CONCLUSION

The clustering approach in this study classified existing station areas into TOD, TAD, and Hybrid types in terms of built-environment factors—density, diversity, and walkability. As a result, 11% of the 549 stations in eight regions were labeled TOD, being dense, diverse, and walkable. One-fifth were named TAD, having the opposite urban form of TOD. The remaining 70% of the stations could be classified as Hybrid. Land use mix was a key factor to distinguish TAD from Hybrid while density and intersection density played important roles to differentiate TOD and Hybrid.

Station area types vary in the literature according to classifying methods, factors and regions. This study has an advantage in considering all the stations in eight urban areas in the U.S. while the majority of them are limited to one region or a few (Atkinson-Palombo and Kuby, 2011; Duncan, 2010; Hale, 2014; Jeihani et al., 2013; Kamruzzaman et al., 2015; Vale, 2015; Ngo, 2012; Pollack et al., 2014; Renne, 2009; Zamir et al., 2014). Renne and Ewing (2013) cover 54 regions across the U.S., but this study utilizes a more objective and systematic analysis—the hierarchical cluster analysis.

Household characteristics and travel behaviors from household travel survey data were matched to each station area type, and this study found that residents living in different types of station area are different from each other. Households in TAD tend to be more affluent, have more cars, include more people, and be more auto-oriented than their counterparts in TOD. Regarding travel behavior, TAD households have far more VMT and fewer walk and transit trips than those in TODs and Hybrids. The average number of daily automobile trips shows the most dramatic differences; TAD households generate three times as many as TOD households (6.06 vs. 2.04). The big difference in mode share between TOD and TAD (e.g. auto mode shares in TAD and TOD are 68% and 25%, respectively) is observed in other studies (Renne, 2009; Renne and Ewing, 2013), sometimes less dramatically—approximately 70% (TOD) vs. 85% (non-TOD) (Kamruzzaman et al., 2013; Jeihani et al., 2013).

Because households in TADs are likely to differ in multiple ways from those in TOD or Hybrid areas, residential self-selection matters when we try to analyze the pure effect of the TOD built environment on travel behaviors. In this study, propensity score matching enables the researcher to match samples so as to control for residential self-selection.

Although the differences in travel outcomes become less dramatic after controlling for self-selection, the matched sample still shows that TOD motivates its residents to walk more and take transit more while using personal vehicles less. The significant difference between TOD and TAD in both VMT and the number of auto trips means that TOD makes the personal vehicle trips both shorter (39% shorter VMT per household) and fewer (35% fewer auto trips per household). By considering the in-between Hybrid type, this study could offer some practical policy suggestions. The result shows that frequencies of auto trips, transit trips, and walk trips are all slightly different between TAD and Hybrid, and only the frequencies of auto and walk trips are significantly different between TOD and Hybrid. Therefore, when a local government and transit authority develop a TAD-type station area which is sprawled, single-use, and not walkable into a Hybrid type mainly by adding different land uses, they could expect small increases in transit and walk trips. Then a Hybrid type of station area could be changed into a TOD type through infill or new developments adding density and/or decreasing block sizes (e.g. adding walking routes through existing blocks), which would result in less driving and more walking by their residents. Then the cumulative change from a TAD to a TOD could encourage its residents to drive shorter and less, walk more, and take transit more, which will have positive impacts on the city’s environment, society, and economy.

Transit-oriented development is expected to promote sustainable travel behavior by reducing auto-dependency and increasing residents’ use of transit and active transportation modes. This study demonstrates that TOD, a station area having a dense, mixed-use, walkable, and transit-friendly environment, could meet these expectations. One application of the study results could be an exploratory, preliminary analysis of the traffic impacts of a TOD project seen in Table 5-2. For example, when a suburban TAD is redeveloped to become a TOD, planners can expect 39% decrease in daily VMT per household, 35% decrease in daily automobile trips, 148% increase in daily transit trips, and 110% increase in daily walk trips. Also, the significant savings in transportation spending in TOD neighborhoods, mainly generated from reduced vehicle use cost, is one social benefit of a dense, mixed-use, and walkable development in a station area, which supports a rationale for TOD.

This study has three main limitations. First, station area classification might generate different results if you change the input—e.g., if you include different regions or different built-environment factors. The result also depends on the clustering method utilized. The classification, because it relies on cluster analysis, cannot provide such guidance as benchmark thresholds of density, land use mix, or street connectivity (see Renne and Ewing, 2013; Renne et al., 2016). Nevertheless, the clustering approach in this study might reflect reality better than using hypothetical benchmarks. Also, the result shows that different station areas have meaningfully different effects on residents' travel.

Second, propensity score matching yields certainty only when all confounding factors are included in the analysis. This study, however, includes only the factors reflecting self-selection indirectly, which are household demographic characteristics—household size, employment, income, vehicle ownership—and location factors—distance to station, regional job accessibility—and does not include, for instance, information on residents' attitudes. The risk of not controlling for all confounding factors is that we might under- or overestimate the effect of residential self-selection on travel behavior. To our knowledge, there are no such attitude data covering multiple regions in the U.S., but this study needs to be checked for external validity by additional TOD studies including residential preference data in specific regions.

Third, in theory, the observed covariates in the propensity score equation are measured before the treatment while the outcome is measured after the treatment (Rosenbaum and Rubin, 1984. In the context of this study, the data point for household characteristics and location factors needs to be before the station area was developed, while the travel outcome data should be collected after the development. This requires longitudinal data. However, because the regional household travel surveys are conducted in different years in each region, it is not plausible to put all longitudinal data into one analysis. Also, even if the data analysis is available, the theoretical propensity score analysis does not fit into the reality of station area developments. Most neighborhoods around stations have been developed over time, meaning that there might be no such "treatment point." Although this study uses cross-sectional data to control the temporal differences across regions and stations, further research needs more advanced methods.

Nevertheless, as a first-of-its-kind study using both cluster analysis and propensity score matching in TOD/TAD classification, this study provides an evidence that a TOD and even a Hybrid station area could encourage its residents to use more active modes of transportation. An effort to create a transit-oriented neighborhood does not have to be a "mega-project." Gradual changes of a station area into a denser, more diverse, and more walkable environment would compensate us in the form of sustainable travel behavior, which ultimately gives environmental, social, and economic benefits.

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9.0 APPENDICES

9.1 APPENDIX A: LIST OF STATION AREAS BY TYPE

Table 1. Station area types and their built-environment characteristics

Cluster type	Number of Stations	Activity Density (/sq.mi.)		Entropy Index		Intersection Density (/sq.mi.)	
		Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
TAD	107	10,319	11,751	0.30	0.19	110	58
Hybrid	382	21,210	19,764	0.75	0.15	194	79
TOD	60	135,327	51,025	0.70	0.24	386	110
TOTAL	**549**	**31,559**	**43,821**	**0.66**	**0.24**	**199**	**108**

Table 2. List of Station Areas by Type (8 regions, 549 stations)

	Station name	Region	Transit Type	Year open	Activity Density (pop+job/ sq.mi.)	Land Use Entropy	Intersection Density	Area Type
1	Arts Center Station	Atlanta	Heavy	Pre-2000	43848	0.50	126	TAD
2	Avondale Station	Atlanta	Heavy	Pre-2000	4495	0.15	135	TAD
3	Bankhead Station	Atlanta	Heavy	Pre-2000	4151	0.43	127	TAD
4	Buckhead Station	Atlanta	Heavy	Pre-2000	30958	0.40	83	TAD
5	Chamblee Station	Atlanta	Heavy	Pre-2000	6624	0.35	72	TAD
6	Doraville Station	Atlanta	Heavy	Pre-2000	6173	0.21	143	TAD
7	Dunwoody Station	Atlanta	Heavy	Pre-2000	22811	0.00	90	TAD
8	East Lake Station	Atlanta	Heavy	Pre-2000	6282	0.37	122	TAD
9	Indian Creek Station	Atlanta	Heavy	Pre-2000	1846	0.00	0	TAD
10	Lenox Station	Atlanta	Heavy	Pre-2000	18016	0.59	81	TAD
11	Lindbergh Center Station	Atlanta	Heavy	Pre-2000	19984	0.51	111	TAD
12	Lindbergh Pocket	Atlanta	Heavy	Pre-2000	20108	0.51	109	TAD
13	Medical Center Station	Atlanta	Heavy	Pre-2000	41794	0.46	86	TAD
14	North Springs Station	Atlanta	Heavy	Pre-2000	11488	0.60	20	TAD
15	Sandy Springs Station	Atlanta	Heavy	Pre-2000	14555	0.18	155	TAD
16	Abington	Boston	Commuter	Pre-2000	2222	0.48	82	TAD
17	Auburndale	Boston	Commuter	Pre-2000	7868	0.26	240	TAD
18	Ballardvale	Boston	Commuter	Pre-2000	1831	0.42	67	TAD
19	Beverly Farms	Boston	Commuter	Pre-2000	805	0.24	79	TAD
20	Bridgewater	Boston	Commuter	Pre-2000	6767	0.51	97	TAD

21	Concord	Boston	Commuter	Pre-2000	2411	0.47	120 TAD
22	Dedham Corp Center	Boston	Commuter	Pre-2000	4365	0.03	115 TAD
23	Endicott	Boston	Commuter	Pre-2000	4542	0.34	170 TAD
24	Halifax	Boston	Commuter	Pre-2000	1045	0.29	66 TAD
25	Hastings	Boston	Commuter	Pre-2000	910	0.28	63 TAD
26	Hersey	Boston	Commuter	Pre-2000	4074	0.20	203 TAD
27	Littleton / Rte 495	Boston	Commuter	Pre-2000	917	0.41	11 TAD
28	Nantasket Junction	Boston	Commuter	2007	1007	0.30	64 TAD
29	North Billerica	Boston	Commuter	Pre-2000	2384	0.30	118 TAD
30	North Scituate	Boston	Commuter	2007	1695	0.45	60 TAD
31	North Wilmington	Boston	Commuter	Pre-2000	2024	0.42	69 TAD
32	Plimptonville	Boston	Commuter	Pre-2000	2407	0.39	78 TAD
33	Prides Crossing	Boston	Commuter	Pre-2000	1144	0.27	42 TAD
34	Rowley	Boston	Commuter	Pre-2000	331	0.46	36 TAD
35	Shirley	Boston	Commuter	Pre-2000	871	0.59	98 TAD
36	Silver Hill	Boston	Commuter	Pre-2000	830	0.09	56 TAD
37	Wellesley Farms	Boston	Commuter	Pre-2000	4428	0.49	116 TAD
38	West Gloucester	Boston	Commuter	Pre-2000	714	0.13	51 TAD
39	West Natick	Boston	Commuter	Pre-2000	6406	0.60	95 TAD
40	Windsor Gardens	Boston	Commuter	Pre-2000	6973	0.44	140 TAD
41	Airport Station	Boston	Heavy	Pre-2000	15982	0.42	172 TAD
42	Wonderland Station—Blue Line	Boston	Heavy	Pre-2000	8429	0.63	65 TAD
43	Beaconsfield Station	Boston	Light	Pre-2000	14891	0.40	198 TAD
44	Capen St	Boston	Light	Pre-2000	5670	0.12	156 TAD
45	Central Ave	Boston	Light	Pre-2000	5165	0.47	122 TAD
46	Newton Centre Station	Boston	Light	Pre-2000	9674	0.23	185 TAD
47	Riverside Station	Boston	Light	Pre-2000	9152	0.50	111 TAD
48	Valley Rd	Boston	Light	Pre-2000	5453	0.19	123 TAD
49	Arapahoe at Village Center Station	Denver	Light	2006	12144	0.57	116 TAD
50	Belleview Station	Denver	Light	2006	22580	0.41	69 TAD
51	County Line Station	Denver	Light	2006	11024	0.00	92 TAD
52	Dayton Station	Denver	Light	2006	11355	0.00	82 TAD
53	Lincoln Station	Denver	Light	2006	8320	0.00	51 TAD
54	Littleton / Mineral Ave Station	Denver	Light	Pre-2000	3833	0.47	72 TAD
55	Louisiana Station	Denver	Light	2006	8865	0.25	174 TAD
56	Nine Mile Station	Denver	Light	2006	1234	0.00	30 TAD
57	Orchard Station	Denver	Light	2006	19252	0.24	166 TAD
58	Southmoor Station	Denver	Light	2006	4892	0.24	126 TAD
59	University of Denver Station	Denver	Light	2006	6467	0.08	159 TAD
60	Yale Station	Denver	Light	2006	7534	0.16	159 TAD

61	Palmetto Station Rail	Miami	Heavy	2003	5215	0.61	48 TAD
62	Coon Rapids Riverdale	Minneapolis	Commuter	2009	3971	0.41	68 TAD
63	Fridley Station	Minneapolis	Commuter	2009	4123	0.41	168 TAD
64	Target Field Station	Minneapolis	Commuter	2009	49971	0.24	177 TAD
65	28 Av Station	Minneapolis	Light	2004	14038	0.00	128 TAD
66	38 St Station	Minneapolis	Light	2004	8738	0.42	141 TAD
67	50 St Minnehaha Sta	Minneapolis	Light	2004	6534	0.09	206 TAD
68	American Blv 34 Av Station	Minneapolis	Light	2004	8496	0.24	76 TAD
69	Bloomington Central Station	Minneapolis	Light	2004	11252	0.23	77 TAD
70	Cedar-Riverside Station	Minneapolis	Light	2004	22704	0.53	98 TAD
71	Franklin Station	Minneapolis	Light	2004	17338	0.24	188 TAD
72	Humphrey Station	Minneapolis	Light	2004	1048	0.00	50 TAD
73	Metrodome Station	Minneapolis	Light	2004	72179	0.17	186 TAD
74	Moa Transit Station	Minneapolis	Light	2004	14738	0.00	179 TAD
75	Va Medical Ctr Sta	Minneapolis	Light	2004	2240	0.07	122 TAD
76	Hall/Nimbus Wes Station	Portland	Commuter	2009	10435	0.56	58 TAD
77	Oregon City	Portland	Commuter	Pre-2000	1851	0.33	110 TAD
78	Wilsonville Wes Station	Portland	Commuter	2009	3584	0.37	38 TAD
79	Albina/Mississippi Max Station	Portland	Light	2004	8399	0.31	185 TAD
80	Cascades Max Station	Portland	Light	2001	3672	0.00	66 TAD
81	Clackamas Town Center TC Max Station	Portland	Light	2009	14795	0.15	23 TAD
82	Convention Center Max Station	Portland	Light	Pre-2000	33815	0.29	246 TAD
83	Delta Park/Vanport Max Station	Portland	Light	2004	952	0.00	38 TAD
84	E 148th Ave Max Station	Portland	Light	Pre-2000	6689	0.41	109 TAD
85	E 162nd Ave Max Station	Portland	Light	Pre-2000	10401	0.45	120 TAD
86	Expo Center Max Station	Portland	Light	2004	124	0.00	25 TAD
87	Fair Complex/Hillsboro Airport Max Stn	Portland	Light	Pre-2000	476	0.50	17 TAD
88	Interstate/Rose Quarter Max Station	Portland	Light	2004	27766	0.32	228 TAD
89	Mt Hood Ave Max Station	Portland	Light	2001	4242	0.00	72 TAD
90	NE 7th Ave Max Station	Portland	Light	Pre-2000	39558	0.34	239 TAD
91	Portland Int’l Airport Max Station	Portland	Light	2001	2655	0.00	103 TAD
92	Rose Quarter TC Max Station	Portland	Light	Pre-2000	29327	0.30	236 TAD
93	SE Flavel St Max Station	Portland	Light	2009	4778	0.54	84 TAD
94	SE Fuller Rd Max Station	Portland	Light	2009	5977	0.62	87 TAD
95	SE Holgate Blvd Max Station	Portland	Light	2009	5128	0.44	160 TAD
96	Sunset TC Max Station	Portland	Light	Pre-2000	8133	0.46	70 TAD
97	Washington Park Max Station	Portland	Light	Pre-2000	1839	0.34	67 TAD
98	2700 West	SaltLakeCity	Light	2011	5967	0.57	104 TAD

99	4800 West	SaltLakeCity	Light	2011	5752	0.42	144	TAD
100	Fort Douglas	SaltLakeCity	Light	2003	23650	0.00	126	TAD
101	Murray North Station	SaltLakeCity	Light	Pre-2000	1538	0.30	0	TAD
102	University Medical Center	SaltLakeCity	Light	2003	17644	0.15	125	TAD
103	University South Campus	SaltLakeCity	Light	2003	27173	0.00	137	TAD
104	Tukwila Station	Seattle	Commuter	2001	7523	0.07	74	TAD
105	Beacon Hill	Seattle	Light	2009	12066	0.27	287	TAD
106	Seatac/Airport	Seattle	Light	2009	7965	0.09	119	TAD
107	Sodo	Seattle	Light	2009	13662	0.41	111	TAD
108	Ashby Station	Atlanta	Heavy	Pre-2000	7199	0.53	211	Hybrid
109	Brookhaven-Oglethorpe Station	Atlanta	Heavy	Pre-2000	4731	0.65	143	Hybrid
110	Civic Center Station	Atlanta	Heavy	Pre-2000	60319	0.52	156	Hybrid
111	College Park Station	Atlanta	Heavy	Pre-2000	3474	0.61	148	Hybrid
112	Decatur Station	Atlanta	Heavy	Pre-2000	12207	0.96	160	Hybrid
113	Dome-Gwcc-Philips Arena-Cnn Station	Atlanta	Heavy	Pre-2000	38495	0.54	195	Hybrid
114	East Point Station	Atlanta	Heavy	Pre-2000	5322	0.50	176	Hybrid
115	Edgewood-Candler Park Station	Atlanta	Heavy	Pre-2000	8986	0.60	144	Hybrid
116	Garnett Station	Atlanta	Heavy	Pre-2000	70657	0.60	204	Hybrid
117	Georgia State Station	Atlanta	Heavy	Pre-2000	51836	0.70	144	Hybrid
118	Hamilton E Holmes Station	Atlanta	Heavy	Pre-2000	4147	0.72	89	Hybrid
119	Inman Park-Reynoldstown Station	Atlanta	Heavy	Pre-2000	7413	0.61	172	Hybrid
120	Kensington Station	Atlanta	Heavy	Pre-2000	5577	0.95	67	Hybrid
121	King Memorial Station	Atlanta	Heavy	Pre-2000	16176	0.80	182	Hybrid
122	Lakewood-Ft McPherson Station	Atlanta	Heavy	Pre-2000	4593	0.88	105	Hybrid
123	Midtown Station	Atlanta	Heavy	Pre-2000	36658	0.79	162	Hybrid
124	North Avenue Station	Atlanta	Heavy	Pre-2000	44952	0.82	137	Hybrid
125	Oakland City Station	Atlanta	Heavy	Pre-2000	5545	0.62	145	Hybrid
126	Vine City Station	Atlanta	Heavy	Pre-2000	8541	0.94	247	Hybrid
127	West End Station	Atlanta	Heavy	Pre-2000	6310	0.53	135	Hybrid
128	West Lake Station	Atlanta	Heavy	Pre-2000	3927	0.78	116	Hybrid
129	Anderson/ Woburn	Boston	Commuter	2011	3107	0.89	24	Hybrid
130	Andover	Boston	Commuter	Pre-2000	7181	0.95	132	Hybrid
131	Ashland	Boston	Commuter	Pre-2000	1005	0.86	39	Hybrid
132	Ayer	Boston	Commuter	Pre-2000	2152	0.88	155	Hybrid
133	Bellevue	Boston	Commuter	Pre-2000	12229	0.65	245	Hybrid
134	Belmont	Boston	Commuter	Pre-2000	7045	0.60	198	Hybrid
135	Beverly	Boston	Commuter	Pre-2000	15918	0.75	326	Hybrid
136	Bradford	Boston	Commuter	Pre-2000	10401	0.56	182	Hybrid
137	Braintree	Boston	Commuter	Pre-2000	4298	1.00	104	Hybrid

138	Brandeis/ Roberts	Boston	Commuter	Pre-2000	10727	0.88	94 Hybrid
139	Brockton	Boston	Commuter	Pre-2000	14893	0.99	229 Hybrid
140	Campello	Boston	Commuter	Pre-2000	9543	0.92	159 Hybrid
141	Canton Center	Boston	Commuter	Pre-2000	6975	0.75	154 Hybrid
142	Canton Junction	Boston	Commuter	Pre-2000	3231	0.66	124 Hybrid
143	Chelsea	Boston	Commuter	Pre-2000	38067	0.92	262 Hybrid
144	Cohasset	Boston	Commuter	2007	732	0.86	37 Hybrid
145	East Weymouth	Boston	Commuter	2007	4586	0.60	131 Hybrid
146	Fairmount	Boston	Commuter	Pre-2000	11962	0.78	223 Hybrid
147	Forest Hills	Boston	Commuter	Pre-2000	13060	0.81	218 Hybrid
148	Forge Park/495	Boston	Commuter	Pre-2000	2538	0.94	64 Hybrid
149	Framingham	Boston	Commuter	Pre-2000	15266	0.99	214 Hybrid
150	Franklin	Boston	Commuter	Pre-2000	6195	0.85	131 Hybrid
151	Gloucester	Boston	Commuter	Pre-2000	14849	0.83	345 Hybrid
152	Greenbush	Boston	Commuter	2007	1246	0.90	105 Hybrid
153	Greenwood	Boston	Commuter	Pre-2000	4626	0.57	162 Hybrid
154	Hamilton/Wenham	Boston	Commuter	Pre-2000	1072	0.75	112 Hybrid
155	Hanson	Boston	Commuter	Pre-2000	474	0.84	35 Hybrid
156	Haverhill	Boston	Commuter	Pre-2000	17860	0.89	296 Hybrid
157	Highland	Boston	Commuter	Pre-2000	10724	0.68	246 Hybrid
158	Holbrook/Randolph	Boston	Commuter	Pre-2000	3303	0.71	113 Hybrid
159	Hyde Park	Boston	Commuter	Pre-2000	12302	0.89	273 Hybrid
160	Ipswich	Boston	Commuter	Pre-2000	6592	0.73	200 Hybrid
161	Islington	Boston	Commuter	Pre-2000	6980	0.76	147 Hybrid
162	JFK/UMass	Boston	Commuter	Pre-2000	21077	0.89	236 Hybrid
163	Kendal Green	Boston	Commuter	Pre-2000	1023	0.70	48 Hybrid
164	Kingston	Boston	Commuter	Pre-2000	1443	0.91	15 Hybrid
165	Lawrence	Boston	Commuter	Pre-2000	15055	0.91	107 Hybrid
166	Lowell	Boston	Commuter	Pre-2000	19373	0.98	287 Hybrid
167	Lynn	Boston	Commuter	Pre-2000	25647	0.97	248 Hybrid
168	Malden Center	Boston	Commuter	Pre-2000	24297	0.89	303 Hybrid
169	Manchester	Boston	Commuter	Pre-2000	930	0.59	137 Hybrid
170	Melrose Cedar Park	Boston	Commuter	Pre-2000	12259	0.67	214 Hybrid
171	Melrose Highlands	Boston	Commuter	Pre-2000	8991	0.51	230 Hybrid
172	Middleboro/Lakeville	Boston	Commuter	Pre-2000	616	0.98	68 Hybrid
173	Mishawum	Boston	Commuter	Pre-2000	10275	0.67	96 Hybrid
174	Montello	Boston	Commuter	Pre-2000	8015	0.68	185 Hybrid
175	Montserrat	Boston	Commuter	Pre-2000	8439	0.57	153 Hybrid
176	Morton Street	Boston	Commuter	Pre-2000	19577	0.68	263 Hybrid
177	Natick	Boston	Commuter	Pre-2000	6788	0.64	274 Hybrid
178	Needham Center	Boston	Commuter	Pre-2000	8019	0.67	212 Hybrid
179	Needham Heights	Boston	Commuter	Pre-2000	7190	0.67	156 Hybrid

180	Needham Junction	Boston	Commuter	Pre-2000	6719	0.61	147 Hybrid
181	Newburyport	Boston	Commuter	Pre-2000	2652	1.00	79 Hybrid
182	Newtonville	Boston	Commuter	Pre-2000	9984	0.57	235 Hybrid
183	Norfolk	Boston	Commuter	Pre-2000	1920	0.70	52 Hybrid
184	North Beverly	Boston	Commuter	Pre-2000	4791	0.74	146 Hybrid
185	Norwood Central	Boston	Commuter	Pre-2000	13121	0.90	208 Hybrid
186	Norwood Depot	Boston	Commuter	Pre-2000	9878	0.79	182 Hybrid
187	Plymouth	Boston	Commuter	Pre-2000	3325	0.75	98 Hybrid
188	Porter Square	Boston	Commuter	Pre-2000	29316	0.48	401 Hybrid
189	Quincy Center	Boston	Commuter	Pre-2000	23964	0.97	223 Hybrid
190	Reading	Boston	Commuter	Pre-2000	7603	0.66	218 Hybrid
191	Readville	Boston	Commuter	Pre-2000	5749	0.89	165 Hybrid
192	River Works	Boston	Commuter	Pre-2000	15898	0.85	125 Hybrid
193	Rockport	Boston	Commuter	Pre-2000	3054	0.73	198 Hybrid
194	Roslindale Village	Boston	Commuter	Pre-2000	14567	0.68	253 Hybrid
195	Route 128	Boston	Commuter	Pre-2000	2660	0.73	24 Hybrid
196	Ruggles	Boston	Commuter	Pre-2000	60084	0.36	305 Hybrid
197	Salem	Boston	Commuter	Pre-2000	16693	0.86	302 Hybrid
198	Sharon	Boston	Commuter	Pre-2000	2063	0.53	137 Hybrid
199	South Acton	Boston	Commuter	Pre-2000	1498	0.72	64 Hybrid
200	South Weymouth	Boston	Commuter	Pre-2000	1345	0.81	50 Hybrid
201	Stoughton	Boston	Commuter	Pre-2000	6545	0.80	209 Hybrid
202	Swampscott	Boston	Commuter	Pre-2000	10049	0.61	294 Hybrid
203	Uphams Corner	Boston	Commuter	Pre-2000	25846	0.83	405 Hybrid
204	Wakefield	Boston	Commuter	Pre-2000	8541	0.89	187 Hybrid
205	Walpole	Boston	Commuter	Pre-2000	1892	0.67	137 Hybrid
206	Waltham	Boston	Commuter	Pre-2000	20089	0.97	266 Hybrid
207	Waverley	Boston	Commuter	Pre-2000	10951	0.78	215 Hybrid
208	Wedgemere	Boston	Commuter	Pre-2000	4433	0.42	211 Hybrid
209	Wellesley Hills	Boston	Commuter	Pre-2000	6235	0.73	150 Hybrid
210	Wellesley Square	Boston	Commuter	Pre-2000	7281	0.88	144 Hybrid
211	West Concord	Boston	Commuter	Pre-2000	3844	0.77	133 Hybrid
212	West Hingham	Boston	Commuter	2007	2331	0.85	55 Hybrid
213	West Medford	Boston	Commuter	Pre-2000	8722	0.45	266 Hybrid
214	West Newton	Boston	Commuter	Pre-2000	8591	0.40	241 Hybrid
215	West Roxbury	Boston	Commuter	Pre-2000	8769	0.73	221 Hybrid
216	Weymouth Landing/East Braintree	Boston	Commuter	2007	6100	0.75	172 Hybrid
217	Whitman	Boston	Commuter	Pre-2000	2590	0.56	128 Hybrid
218	Wilmington	Boston	Commuter	Pre-2000	2716	0.85	89 Hybrid
219	Winchester Center	Boston	Commuter	Pre-2000	7851	0.81	240 Hybrid
220	Wyoming Hill	Boston	Commuter	Pre-2000	8231	0.45	273 Hybrid

221	Yawkey	Boston	Commuter	Pre-2000	60896	0.90	218 Hybrid
222	Alewife Station Red Line	Boston	Heavy	Pre-2000	16673	0.92	67 Hybrid
223	Andrew Sq Station	Boston	Heavy	Pre-2000	19239	0.89	328 Hybrid
224	Beachmont Station	Boston	Heavy	Pre-2000	11374	0.89	243 Hybrid
225	Braintree Station Red Line Platform	Boston	Heavy	Pre-2000	4107	1.00	107 Hybrid
226	Broadway Station	Boston	Heavy	Pre-2000	24843	0.73	282 Hybrid
227	Central Sq	Boston	Heavy	Pre-2000	49276	0.75	464 Hybrid
228	Community College	Boston	Heavy	Pre-2000	25957	0.79	284 Hybrid
229	Davis Sq	Boston	Heavy	Pre-2000	32443	0.59	408 Hybrid
230	Fields Corner Station	Boston	Heavy	Pre-2000	28562	0.81	314 Hybrid
231	Forest Hills Orange Line	Boston	Heavy	Pre-2000	13183	0.81	225 Hybrid
232	Harvard Station	Boston	Heavy	Pre-2000	62875	0.84	283 Hybrid
233	Jackson Sq	Boston	Heavy	Pre-2000	27511	0.81	342 Hybrid
234	JFK/UMass Ashmont Line Inbound	Boston	Heavy	Pre-2000	21040	0.89	213 Hybrid
235	Kendall/MIT Station	Boston	Heavy	Pre-2000	51253	0.74	191 Hybrid
236	Malden Station	Boston	Heavy	Pre-2000	24866	0.96	299 Hybrid
237	Maverick Station	Boston	Heavy	Pre-2000	32814	0.90	343 Hybrid
238	North Quincy Station	Boston	Heavy	Pre-2000	13102	0.92	186 Hybrid
239	Oak Grove Station—Orange Line	Boston	Heavy	Pre-2000	14129	0.55	276 Hybrid
240	Orient Heights Station	Boston	Heavy	Pre-2000	11838	0.85	213 Hybrid
241	Porter Sq	Boston	Heavy	Pre-2000	29254	0.48	401 Hybrid
242	Quincy Adams Station	Boston	Heavy	Pre-2000	10795	0.99	148 Hybrid
243	Quincy Center Station	Boston	Heavy	Pre-2000	24155	0.94	256 Hybrid
244	Revere Beach Station	Boston	Heavy	Pre-2000	17468	0.95	228 Hybrid
245	Roxbury Xng	Boston	Heavy	Pre-2000	37161	0.68	311 Hybrid
246	Ruggles Station	Boston	Heavy	Pre-2000	63505	0.51	328 Hybrid
247	Savin Hill Station	Boston	Heavy	Pre-2000	17093	0.86	220 Hybrid
248	Shawmut Station	Boston	Heavy	Pre-2000	25559	0.56	311 Hybrid
249	Stoneybrook	Boston	Heavy	Pre-2000	25654	0.71	387 Hybrid
250	Suffolk Downs Station	Boston	Heavy	Pre-2000	10053	0.79	120 Hybrid
251	Sullivan Station	Boston	Heavy	Pre-2000	17734	1.00	328 Hybrid
252	Wellington Station	Boston	Heavy	Pre-2000	11778	1.00	83 Hybrid
253	Wollaston Station	Boston	Heavy	Pre-2000	14055	0.66	277 Hybrid
254	Wood Island Station	Boston	Heavy	Pre-2000	16911	0.84	229 Hybrid
255	Allston St	Boston	Light	Pre-2000	42418	0.77	303 Hybrid
256	Ashmont Station	Boston	Light	Pre-2000	21804	0.57	285 Hybrid
257	Babcock St	Boston	Light	Pre-2000	47825	0.87	254 Hybrid
258	Back of Hill	Boston	Light	Pre-2000	36403	0.78	267 Hybrid
259	Blandford St	Boston	Light	Pre-2000	68490	0.84	268 Hybrid
260	Boston College Station	Boston	Light	Pre-2000	16987	0.78	108 Hybrid

261 Boston Univ Central	Boston	Light	Pre-2000	46716	0.92	253 Hybrid
262 Boston Univ East	Boston	Light	Pre-2000	59962	0.88	306 Hybrid
263 Boston Univ West	Boston	Light	Pre-2000	39045	0.92	223 Hybrid
264 Brandon Hall	Boston	Light	Pre-2000	32192	0.57	244 Hybrid
265 Brookline Hills Station	Boston	Light	Pre-2000	19085	0.64	270 Hybrid
266 Brookline Village Station	Boston	Light	Pre-2000	29978	0.86	310 Hybrid
267 Butler Station	Boston	Light	Pre-2000	11244	0.90	127 Hybrid
268 Cedar Grove	Boston	Light	Pre-2000	10433	0.74	215 Hybrid
269 Chestnut Hill Ave	Boston	Light	Pre-2000	26288	0.71	258 Hybrid
270 Chestnut Hill Station	Boston	Light	Pre-2000	3779	0.70	122 Hybrid
271 Chiswick Rd	Boston	Light	Pre-2000	32937	0.57	300 Hybrid
272 Cleveland Circle Platform	Boston	Light	Pre-2000	20786	0.67	226 Hybrid
273 Coolidge Corner	Boston	Light	Pre-2000	36074	0.68	245 Hybrid
274 Dean Rd	Boston	Light	Pre-2000	23285	0.52	249 Hybrid
275 Eliot Station	Boston	Light	Pre-2000	6232	0.42	215 Hybrid
276 Englewood Ave	Boston	Light	Pre-2000	24179	0.65	282 Hybrid
277 Fairbanks St	Boston	Light	Pre-2000	25477	0.53	189 Hybrid
278 Fenway Station	Boston	Light	Pre-2000	55097	0.91	203 Hybrid
279 Griggs St	Boston	Light	Pre-2000	48881	0.80	330 Hybrid
280 Harvard Ave	Boston	Light	Pre-2000	44685	0.71	351 Hybrid
281 Hawes St	Boston	Light	Pre-2000	30492	0.75	250 Hybrid
282 Heath St Platform	Boston	Light	Pre-2000	34350	0.77	256 Hybrid
283 Kenmore Station	Boston	Light	Pre-2000	58572	0.88	238 Hybrid
284 Kent St	Boston	Light	Pre-2000	31773	0.72	240 Hybrid
285 Lechmere	Boston	Light	Pre-2000	43217	0.97	245 Hybrid
286 Longwood Med Area	Boston	Light	Pre-2000	92247	0.60	301 Hybrid
287 Longwood Station	Boston	Light	Pre-2000	60625	0.76	215 Hybrid
288 Mattapan Station	Boston	Light	Pre-2000	13204	0.80	263 Hybrid
289 Milton Station	Boston	Light	Pre-2000	7902	0.74	160 Hybrid
290 Museum of Fine Arts	Boston	Light	Pre-2000	76287	0.32	263 Hybrid
291 Newton Highlands Station	Boston	Light	Pre-2000	7553	0.42	249 Hybrid
292 Northeastern	Boston	Light	Pre-2000	74363	0.56	259 Hybrid
293 Packards Corner	Boston	Light	Pre-2000	49880	0.85	299 Hybrid
294 Pleasant St	Boston	Light	Pre-2000	46934	0.91	273 Hybrid
295 Reservoir Station	Boston	Light	Pre-2000	18019	0.68	211 Hybrid
296 Riverway	Boston	Light	Pre-2000	48399	0.82	297 Hybrid
297 Saint Mary St	Boston	Light	Pre-2000	41125	0.92	232 Hybrid
298 Saint Paul St/Beacon	Boston	Light	Pre-2000	33430	0.72	244 Hybrid
299 Saint Paul St/Commonwealth	Boston	Light	Pre-2000	41695	0.93	232 Hybrid
300 Science Park	Boston	Light	Pre-2000	81457	0.75	235 Hybrid
301 South St	Boston	Light	Pre-2000	23519	0.70	208 Hybrid
302 Summit Ave	Boston	Light	Pre-2000	36972	0.63	232 Hybrid

303 Sutherland Rd	Boston	Light	Pre-2000	36762	0.56	307 Hybrid
304 Tappan St	Boston	Light	Pre-2000	22272	0.45	224 Hybrid
305 Waban Station	Boston	Light	Pre-2000	4649	0.56	155 Hybrid
306 Warren St	Boston	Light	Pre-2000	39932	0.83	311 Hybrid
307 Washington Sq	Boston	Light	Pre-2000	25229	0.48	210 Hybrid
308 Washington St	Boston	Light	Pre-2000	36362	0.68	273 Hybrid
309 Woodland Station	Boston	Light	Pre-2000	8986	0.70	66 Hybrid
310 10th and Osage Station	Denver	Light	Pre-2000	12220	0.75	125 Hybrid
311 25th And Welton Station	Denver	Light	Pre-2000	13158	0.62	211 Hybrid
312 27th and Welton Station	Denver	Light	Pre-2000	13431	0.50	209 Hybrid
313 29th and Welton Station	Denver	Light	Pre-2000	13188	0.41	225 Hybrid
314 30th and Downing Station	Denver	Light	Pre-2000	12629	0.44	221 Hybrid
315 Alameda Station	Denver	Light	Pre-2000	13119	0.89	115 Hybrid
316 Auraria West Station	Denver	Light	2002	6870	0.98	123 Hybrid
317 Colfax at Auraria Station	Denver	Light	Pre-2000	17784	0.87	188 Hybrid
318 Colorado Station	Denver	Light	2006	16669	0.80	121 Hybrid
319 Dry Creek Station	Denver	Light	2006	11596	0.77	165 Hybrid
320 Englewood Station	Denver	Light	Pre-2000	11859	1.00	146 Hybrid
321 Evans Station	Denver	Light	Pre-2000	7444	0.82	139 Hybrid
322 Hwy I-25 and Broadway Stn	Denver	Light	Pre-2000	7446	0.72	53 Hybrid
323 Invesco Field at Mile High Station	Denver	Light	2002	4852	0.82	113 Hybrid
324 Littleton / Downtown Station	Denver	Light	Pre-2000	12414	0.78	151 Hybrid
325 Oxford—City of Sheridan Station	Denver	Light	Pre-2000	6104	0.86	77 Hybrid
326 Pepsi Center/Elitch’s Stn	Denver	Light	2002	15479	0.56	166 Hybrid
327 Theatre District/Convention Ctr Stn	Denver	Light	Pre-2000	84391	0.48	236 Hybrid
328 Union Station Lrt	Denver	Light	2002	72046	0.69	210 Hybrid
329 Golden Glades	Miami	Commuter	Pre-2000	5516	0.77	33 Hybrid
330 Hialeah Market	Miami	Commuter	Pre-2000	9487	0.57	159 Hybrid
331 Metrorail Transfer	Miami	Commuter	Pre-2000	5806	0.78	168 Hybrid
332 Opa-Locka	Miami	Commuter	Pre-2000	7991	0.74	209 Hybrid
333 Allapattah Station Rail	Miami	Heavy	Pre-2000	14066	0.63	249 Hybrid
334 Brickell Station Rail	Miami	Heavy	Pre-2000	52522	0.85	216 Hybrid
335 Brownsville Station Rail	Miami	Heavy	Pre-2000	9981	0.78	260 Hybrid
336 Civic Cntr. Station Rail	Miami	Heavy	Pre-2000	46447	0.59	172 Hybrid
337 Coconut Grove Station	Miami	Heavy	Pre-2000	15310	0.61	321 Hybrid
338 Culmer Station Rail	Miami	Heavy	Pre-2000	13200	0.89	169 Hybrid
339 Dadeland North Station Rail	Miami	Heavy	Pre-2000	13672	0.78	168 Hybrid
340 Dadeland South Station Rail	Miami	Heavy	Pre-2000	25731	0.70	140 Hybrid
341 Douglas Road Station Rail	Miami	Heavy	Pre-2000	18505	0.90	251 Hybrid
342 Earlington Hts. Stat. Rail	Miami	Heavy	Pre-2000	11004	0.78	198 Hybrid

343	Government Ctr. Stat. Rail	Miami	Heavy	Pre-2000	51747	0.75	187 Hybrid
344	Hialeah Station Rail	Miami	Heavy	Pre-2000	14676	0.74	195 Hybrid
345	M.L. King Station Rail	Miami	Heavy	Pre-2000	9093	0.88	255 Hybrid
346	Northside Station Rail	Miami	Heavy	Pre-2000	7097	0.86	188 Hybrid
347	Okeechobee Station Rail	Miami	Heavy	Pre-2000	10104	0.88	145 Hybrid
348	Overtown/Arena Stat. Rail	Miami	Heavy	Pre-2000	33123	0.91	188 Hybrid
349	Santa Clara Station Rail	Miami	Heavy	Pre-2000	27716	0.93	182 Hybrid
350	South Miami Station Rail	Miami	Heavy	Pre-2000	22176	0.92	260 Hybrid
351	Tri-Rail Station Rail	Miami	Heavy	Pre-2000	7957	0.73	172 Hybrid
352	University Station Rail	Miami	Heavy	Pre-2000	10583	0.92	222 Hybrid
353	Vizcaya Station Rail	Miami	Heavy	Pre-2000	9455	0.71	231 Hybrid
354	Arena/State Plaza Station	Miami	Light	Pre-2000	43698	0.78	194 Hybrid
355	Bayfront Park Station	Miami	Light	Pre-2000	76220	0.63	182 Hybrid
356	Bicentennial Park Station	Miami	Light	Pre-2000	17749	0.69	187 Hybrid
357	Brickell Metromover Station	Miami	Light	Pre-2000	51204	0.87	232 Hybrid
358	College North Station	Miami	Light	Pre-2000	47438	0.71	180 Hybrid
359	College/Bayside Station	Miami	Light	Pre-2000	56666	0.64	193 Hybrid
360	Eighth Street Station	Miami	Light	Pre-2000	67315	0.67	181 Hybrid
361	Eleventh Street Station	Miami	Light	Pre-2000	16889	0.83	229 Hybrid
362	Fifth Street Station	Miami	Light	Pre-2000	67212	0.55	165 Hybrid
363	Financial District Station	Miami	Light	Pre-2000	60024	0.89	179 Hybrid
364	First Street Station	Miami	Light	Pre-2000	69395	0.65	192 Hybrid
365	Government Center Station	Miami	Light	Pre-2000	50824	0.76	185 Hybrid
366	Knight Center Station	Miami	Light	Pre-2000	76995	0.55	196 Hybrid
367	NE 2 Ave @NE 2 St	Miami	Light	Pre-2000	69395	0.65	192 Hybrid
368	NE 2 Ave @NE 4 St	Miami	Light	Pre-2000	56666	0.64	193 Hybrid
369	NE 2 Ave @NE 7 St	Miami	Light	Pre-2000	28767	0.73	173 Hybrid
370	NE 2 Ave @NE 8 St	Miami	Light	Pre-2000	20880	0.76	174 Hybrid
371	NW 1 Ave @NW 5 St	Miami	Light	Pre-2000	43698	0.78	194 Hybrid
372	Omni Metromover Station	Miami	Light	Pre-2000	25028	0.79	231 Hybrid
373	Riverwalk Station	Miami	Light	Pre-2000	72265	0.55	183 Hybrid
374	School Board Station	Miami	Light	Pre-2000	15052	0.88	260 Hybrid
375	SE 4 St @S Miami Ave	Miami	Light	Pre-2000	67470	0.61	179 Hybrid
376	SW 1 St @S Miami Ave	Miami	Light	Pre-2000	69395	0.65	192 Hybrid
377	Tenth Street Promenade Station	Miami	Light	Pre-2000	65303	0.81	198 Hybrid
378	Anoka Station	Minneapolis	Commuter	2009	4171	0.66	133 Hybrid
379	46 St Station	Minneapolis	Light	2004	7014	0.54	142 Hybrid
380	Lake St Midtown Sta	Minneapolis	Light	2004	9613	0.63	113 Hybrid
381	Beaverton TC Wes Station	Portland	Commuter	Pre-2000	10471	0.79	218 Hybrid
382	Pdx	Portland	Commuter	Pre-2000	48591	0.62	363 Hybrid
383	Tigard TC Wes Station	Portland	Commuter	2009	9010	0.96	133 Hybrid
384	Tualatin Wes Station	Portland	Commuter	2009	8455	0.92	111 Hybrid

385	Beaverton Central Max Station	Portland	Light	Pre-2000	10194	0.71	201 Hybrid
386	Beaverton Creek Max Station	Portland	Light	Pre-2000	11602	0.91	32 Hybrid
387	Beaverton TC Max Station	Portland	Light	Pre-2000	10437	0.80	205 Hybrid
388	Civic Drive Max Station	Portland	Light	Pre-2000	11660	0.84	140 Hybrid
389	Cleveland Ave Max Station	Portland	Light	Pre-2000	7916	0.74	159 Hybrid
390	E 102nd Ave Max Station	Portland	Light	Pre-2000	14198	0.78	206 Hybrid
391	E 122nd Ave Max Station	Portland	Light	Pre-2000	8211	0.87	148 Hybrid
392	E 172nd Ave Max Station	Portland	Light	Pre-2000	8779	0.58	140 Hybrid
393	E 181st Ave Max Station	Portland	Light	Pre-2000	9344	0.75	138 Hybrid
394	Elmonica/SW 170th Ave Max Station	Portland	Light	Pre-2000	9155	0.80	136 Hybrid
395	Gateway/NE 99th Ave Tc Max Station	Portland	Light	Pre-2000	9511	0.89	176 Hybrid
396	Goose Hollow/SW Jefferson St Max Station	Portland	Light	Pre-2000	27906	0.94	306 Hybrid
397	Gresham Central TC Max Station	Portland	Light	Pre-2000	8855	0.84	195 Hybrid
398	Gresham City Hall Max Station	Portland	Light	Pre-2000	9632	0.86	163 Hybrid
399	Hatfield Government Center Max Station	Portland	Light	Pre-2000	12063	0.97	168 Hybrid
400	Hawthorn Farm Max Station	Portland	Light	Pre-2000	9366	0.76	53 Hybrid
401	Hillsboro Central/SE 3rd Tc Max Station	Portland	Light	Pre-2000	11134	0.99	175 Hybrid
402	Hollywood/NE 42nd Ave Tc Max Station	Portland	Light	Pre-2000	15740	0.78	269 Hybrid
403	Kenton/N Denver Ave Max Station	Portland	Light	2004	6396	0.66	241 Hybrid
404	Kings Hill/SW Salmon St Max Station	Portland	Light	Pre-2000	38267	1.00	375 Hybrid
405	Lents/SE Foster Rd Max Station	Portland	Light	2009	6290	0.58	234 Hybrid
406	Lloyd Center/NE 11th Ave Max Station	Portland	Light	Pre-2000	35614	0.43	216 Hybrid
407	Marquam Hill Upper Tram Terminal	Portland	Light	2006	33561	0.74	47 Hybrid
408	Merlo Rd/SW 158th Ave Max Station	Portland	Light	Pre-2000	9838	0.73	52 Hybrid
409	Millikan Way Max Station	Portland	Light	Pre-2000	10479	0.68	75 Hybrid
410	N Killingsworth St Max Station	Portland	Light	2004	9543	0.55	311 Hybrid
411	N Lombard TC Max Station	Portland	Light	2004	8803	0.52	241 Hybrid
412	N Prescott St Max Station	Portland	Light	2004	9076	0.54	285 Hybrid
413	NE 60th Ave Max Station	Portland	Light	Pre-2000	11920	0.52	257 Hybrid
414	NE 82nd Ave Max Station	Portland	Light	Pre-2000	7363	0.53	218 Hybrid
415	Orenco/NW 231St Ave Max Station	Portland	Light	Pre-2000	8038	0.67	198 Hybrid
416	Overlook Park Max Station	Portland	Light	2004	10154	0.80	233 Hybrid

417	Parkrose/Sumner TC Max Station	Portland	Light	2001	6247	0.60	160 Hybrid
418	PGE Park Max Station	Portland	Light	Pre-2000	46725	0.99	401 Hybrid
419	Quatama/NW 205th Ave Max Station	Portland	Light	Pre-2000	6858	0.56	185 Hybrid
420	Rockwood/E 188th Ave Max Station	Portland	Light	Pre-2000	9047	0.66	138 Hybrid
421	Rosa Parks Max Station	Portland	Light	2004	8979	0.34	255 Hybrid
422	Ruby Junction/E 197th Ave Max Station	Portland	Light	Pre-2000	7317	0.73	70 Hybrid
423	SE Division St Max Station	Portland	Light	2009	6253	0.66	125 Hybrid
424	SE Main St Max Station	Portland	Light	2009	12018	0.97	102 Hybrid
425	SE Powell Blvd Max Station	Portland	Light	2009	5706	0.99	80 Hybrid
426	South Waterfront Lower Tram Terminal	Portland	Light	2006	15842	0.86	241 Hybrid
427	Tuality Hospital/SE 8th Ave Max Station	Portland	Light	Pre-2000	9942	0.95	173 Hybrid
428	Union Station/NW 5th and Glisan St Max Stn	Portland	Light	2009	62076	0.56	380 Hybrid
429	Union Station/NW 6th and Hoyt St Max Stn	Portland	Light	2009	56546	0.60	374 Hybrid
430	Washington/SE 12th Ave Max Station	Portland	Light	Pre-2000	8850	0.73	156 Hybrid
431	Willow Creek/SW 185th Ave TC Max Station	Portland	Light	Pre-2000	7563	0.78	111 Hybrid
432	Salt Lake Central Station	SaltLakeCity	Commuter	2008	11193	0.67	102 Hybrid
433	900 East Station	SaltLakeCity	Light	2005	19412	0.72	224 Hybrid
434	900 South	SaltLakeCity	Light	2005	11441	0.90	196 Hybrid
435	Arena	SaltLakeCity	Light	Pre-2000	34913	0.85	127 Hybrid
436	Ball Park Station	SaltLakeCity	Light	Pre-2000	9803	0.75	150 Hybrid
437	Bingham Junction	SaltLakeCity	Light	2011	2208	0.84	0 Hybrid
438	City Center Station	SaltLakeCity	Light	Pre-2000	79778	0.85	158 Hybrid
439	Courthouse Station	SaltLakeCity	Light	Pre-2000	44089	0.70	160 Hybrid
440	Decker Lake	SaltLakeCity	Light	2011	12034	0.98	103 Hybrid
441	Fashion Place West	SaltLakeCity	Light	Pre-2000	6432	0.78	103 Hybrid
442	Gallivan Plaza	SaltLakeCity	Light	Pre-2000	69939	0.82	153 Hybrid
443	Historic Gardner	SaltLakeCity	Light	2011	5210	0.99	67 Hybrid
444	Historic Sandy	SaltLakeCity	Light	Pre-2000	7825	0.79	316 Hybrid
445	Jordan Valley	SaltLakeCity	Light	2011	7158	0.77	140 Hybrid
446	Library Station	SaltLakeCity	Light	2001	51383	0.88	154 Hybrid
447	Meadowbrook Station	SaltLakeCity	Light	Pre-2000	8402	0.96	78 Hybrid
448	Midvale Center Station	SaltLakeCity	Light	Pre-2000	5888	0.80	124 Hybrid
449	Midvale Fort Union	SaltLakeCity	Light	Pre-2000	5782	0.60	171 Hybrid
450	Millcreek Station	SaltLakeCity	Light	Pre-2000	9570	0.95	87 Hybrid
451	Murray Central Station	SaltLakeCity	Light	Pre-2000	22484	0.96	118 Hybrid

452	Old Greektown	SaltLakeCity	Light	2008	26032	0.88	107	Hybrid
453	Planetarium	SaltLakeCity	Light	2008	31259	0.86	127	Hybrid
454	Redwood Junction	SaltLakeCity	Light	2011	8011	0.92	108	Hybrid
455	River Trail	SaltLakeCity	Light	2011	10847	0.97	78	Hybrid
456	Sandy Civic Center	SaltLakeCity	Light	Pre-2000	6289	0.60	148	Hybrid
457	Sandy Expo	SaltLakeCity	Light	2006	11953	0.98	112	Hybrid
458	Stadium	SaltLakeCity	Light	2001	17826	0.71	107	Hybrid
459	Temple Square Station	SaltLakeCity	Light	Pre-2000	55670	0.86	133	Hybrid
460	Trolley Square Station	SaltLakeCity	Light	2001	24387	0.80	195	Hybrid
461	West Jordan City Center	SaltLakeCity	Light	2011	6934	0.54	176	Hybrid
462	West Valley Central Station	SaltLakeCity	Light	2011	11866	0.86	154	Hybrid
463	Auburn Station	Seattle	Commuter	Pre-2000	5103	0.85	176	Hybrid
464	Edmonds Station	Seattle	Commuter	2003	2689	0.71	104	Hybrid
465	Everett Station	Seattle	Commuter	2003	12479	0.76	139	Hybrid
466	Kent Station	Seattle	Commuter	2001	5888	0.97	172	Hybrid
467	King Street Station	Seattle	Commuter	Pre-2000	69723	0.87	319	Hybrid
468	Mukilteo Station	Seattle	Commuter	2003	684	0.68	141	Hybrid
469	Puyallup Station	Seattle	Commuter	2001	6993	0.89	230	Hybrid
470	Sumner Station	Seattle	Commuter	Pre-2000	4676	0.75	184	Hybrid
471	Tacoma	Seattle	Commuter	Pre-2000	4356	0.67	138	Hybrid
472	Tacoma Dome Station	Seattle	Commuter	Pre-2000/2003	4300	0.64	127	Hybrid
473	Columbia City	Seattle	Light	2009	10869	0.67	247	Hybrid
474	Commerce Street Station	Seattle	Light	2003	36046	0.76	232	Hybrid
475	Convention Center Station	Seattle	Light	2003	32222	0.91	242	Hybrid
476	Fairview Ave N and Aloha St	Seattle	Light	2007	26920	0.74	174	Hybrid
477	Mount Baker	Seattle	Light	2009	10356	0.85	239	Hybrid
478	Othello	Seattle	Light	2009	10728	0.66	167	Hybrid
479	Rainier Beach	Seattle	Light	2009	6085	0.57	170	Hybrid
480	SLU Streetcar and Terry Ave N	Seattle	Light	2007	31522	0.75	238	Hybrid
481	South 25th Street Station	Seattle	Light	2003	5688	0.93	181	Hybrid
482	Stadium	Seattle	Light	2009	18796	0.66	157	Hybrid
483	Terry Ave N and Republican St	Seattle	Light	2007	36786	0.83	260	Hybrid
484	Terry Ave N and Thomas St	Seattle	Light	2007	49702	0.83	274	Hybrid
485	Theater District Station	Seattle	Light	2003	36578	0.81	212	Hybrid
486	Tukwila International Blvd	Seattle	Light	2009	5500	0.73	104	Hybrid
487	Union Station	Seattle	Light	2003	14885	0.88	230	Hybrid
488	Westlake Ave N and Harrison St	Seattle	Light	2007	53745	0.81	289	Hybrid
489	Westlake Ave N and Mercer St	Seattle	Light	2007	33921	0.80	256	Hybrid
490	Five Points Station	Atlanta	Heavy	Pre-2000	117818	0.50	260	TOD

491	Peachtree Center Station	Atlanta	Heavy	Pre-2000	117224	0.31	245 TOD
492	Back Bay	Boston	Commuter	Pre-2000	139580	0.99	310 TOD
493	Aquarium Station	Boston	Heavy	Pre-2000	209757	0.96	536 TOD
494	Back Bay Station	Boston	Heavy	Pre-2000	139941	0.99	308 TOD
495	Bowdoin Station Blue Line	Boston	Heavy	Pre-2000	206501	0.95	576 TOD
496	Charles/Mgh Station	Boston	Heavy	Pre-2000	82861	0.74	436 TOD
497	Chinatown Station	Boston	Heavy	Pre-2000	187134	0.94	455 TOD
498	Downtown Crossing	Boston	Heavy	Pre-2000	283934	0.93	504 TOD
499	Government Ctr Station	Boston	Heavy	Pre-2000	244676	0.94	540 TOD
500	Haymarket	Boston	Heavy	Pre-2000	189203	0.97	634 TOD
501	Massachusetts Ave Station	Boston	Heavy	Pre-2000	80296	0.87	360 TOD
502	North Station	Boston	Heavy	Pre-2000	94767	0.91	527 TOD
503	Park St Station	Boston	Heavy	Pre-2000	274644	0.97	507 TOD
504	South Station	Boston	Heavy	Pre-2000	216171	0.95	409 TOD
505	State St Station	Boston	Heavy	Pre-2000	250530	0.91	544 TOD
506	Tufts Medical Ctr	Boston	Heavy	Pre-2000	129180	0.93	423 TOD
507	Arlington Station	Boston	Light	Pre-2000	135560	0.96	338 TOD
508	Boylston Station	Boston	Light	Pre-2000	187240	0.94	459 TOD
509	Brigham Circle	Boston	Light	Pre-2000	105570	0.74	330 TOD
510	Copley Station	Boston	Light	Pre-2000	151055	0.99	243 TOD
511	Fenwood Rd	Boston	Light	Pre-2000	103590	0.78	344 TOD
512	Government Center Station	Boston	Light	Pre-2000	244676	0.94	540 TOD
513	Hynes Station	Boston	Light	Pre-2000	81687	0.97	252 TOD
514	Mission Park	Boston	Light	Pre-2000	80551	0.88	326 TOD
515	Prudential Station	Boston	Light	Pre-2000	108649	0.99	302 TOD
516	Symphony Station	Boston	Light	Pre-2000	86228	0.89	348 TOD
517	16th and California Station	Denver	Light	Pre-2000	139179	0.39	241 TOD
518	16th and Stout Station	Denver	Light	Pre-2000	143196	0.45	220 TOD
519	18th and California Station	Denver	Light	Pre-2000	132834	0.59	228 TOD
520	18th and Stout Station	Denver	Light	Pre-2000	128021	0.68	227 TOD
521	20th and Welton Station	Denver	Light	Pre-2000	104711	0.83	220 TOD
522	Govt Plaza Station	Minneapolis	Light	2004	155399	0.63	215 TOD
523	Nicollet Mall Station	Minneapolis	Light	2004	174036	0.57	214 TOD
524	Warehouse Station	Minneapolis	Light	2004	132309	0.61	200 TOD
525	City Hall/SW 5th and Jefferson St Max Stn	Portland	Light	2009	112145	0.71	393 TOD
526	Galleria/SW 10th Ave Max Station	Portland	Light	Pre-2000	99968	0.83	459 TOD
527	Library/SW 9th Ave Max Station	Portland	Light	Pre-2000	109588	0.80	448 TOD
528	Mall/SW 4th Ave Max Station	Portland	Light	Pre-2000	127230	0.43	460 TOD
529	Mall/SW 5th Ave Max Station	Portland	Light	Pre-2000	125151	0.48	475 TOD

530	Morrison/SW 3rd Ave Max Station	Portland	Light	Pre-2000	128148	0.27	455 TOD
531	NW 5th and Couch St Max Station	Portland	Light	2009	84316	0.37	448 TOD
532	NW 6th and Davis St Max Station	Portland	Light	2009	80541	0.39	449 TOD
533	Oak/ SW 1st Ave Max Station	Portland	Light	Pre-2000	102246	0.20	465 TOD
534	Old Town/Chinatown Max Station	Portland	Light	Pre-2000	68383	0.48	436 TOD
535	Pioneer Courthouse/Sw 6th Ave Max Stn	Portland	Light	2009	121964	0.57	459 TOD
536	Pioneer Place/SW 5th Ave Max Station	Portland	Light	2009	125023	0.50	447 TOD
537	Pioneer Square North Max Station	Portland	Light	Pre-2000	116398	0.66	449 TOD
538	Pioneer Square South Max Station	Portland	Light	Pre-2000	122472	0.61	467 TOD
539	PSU/SW 5th and Mill St Max Station	Portland	Light	2009	92574	0.71	349 TOD
540	PSU/SW 6th and Montgomery St Max Station	Portland	Light	2009	84898	0.73	334 TOD
541	Skidmore Fountain Max Station	Portland	Light	Pre-2000	82096	0.37	448 TOD
542	SW 5th and Oak St Max Station	Portland	Light	2009	103676	0.35	458 TOD
543	SW 6th and Madison St Max Station	Portland	Light	2009	113591	0.69	395 TOD
544	SW 6th and Pine St Max Station	Portland	Light	2009	95881	0.40	481 TOD
545	Yamhill District Max Station	Portland	Light	Pre-2000	130935	0.16	429 TOD
546	Westlake Ave and 7th Ave	Seattle	Light	2007	131159	0.71	278 TOD
547	Westlake Ave and 9th Ave	Seattle	Light	2007	97654	0.77	289 TOD
548	Westlake Ave and Olive Way	Seattle	Light	2007	164945	0.64	278 TOD
549	Westlake Ave and Virginia St	Seattle	Light	2007	139911	0.70	282 TOD

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