

City of Des Moines Comprehensive Transportation Plan June 2009

APPENDIX A

BACKGROUND ON THE DES MOINES TRAVEL DEMAND MODEL

Appendix A: Travel Model Background



BACKGROUND ON THE DES MOINES TRAVEL DEMAND MODEL

This appendix provides a general overview about the travel demand modeling process and documentation, including a brief description of the modeling process, the assumptions used in the analysis to predict future travel demand, and the model validation process.

Introduction

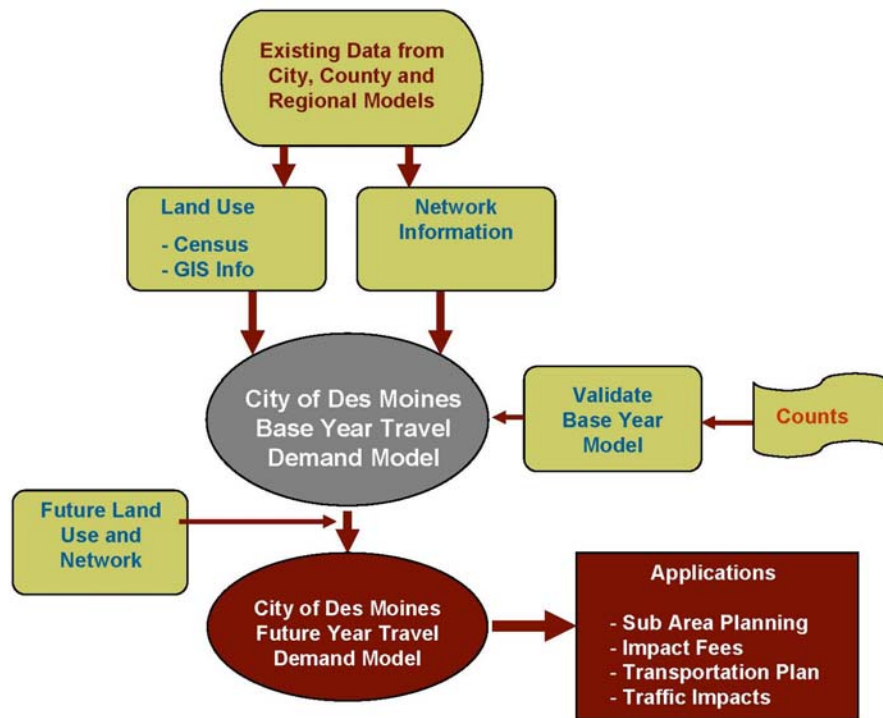
Forecasting future travel demand is a key step in the transportation-planning process. The forecast provides the foundation for a variety of studies including transportation needs analyses, comprehensive plans, EIS studies, detailed operational analyses, and design projects. A travel demand forecasting model can be used for both regional analysis and subarea studies including cities. For subarea studies, the regional model is refined to provide greater level of detail in a focused study area than would be provided at the regional modeling level.

We use travel models to determine the quantitative relationship between land development and the need for future roadway network improvements. Understanding the future nature of traffic volumes and travel patterns in a study area makes it possible to recommend an appropriate set of future transportation improvements. The forecast of future travel demand builds upon an understanding of existing traffic volumes and flow patterns, future land use, and the city's proposed plans.

Travel demand model documentation is as important as the model itself. It is important to document the model input assumptions in order to understand its capabilities and flexibility. Good documentation provides information for all users, not only the technical experts who run the models, but also the planners who use information from the model. This report documents the model developed for the City of Des Moines.

In transportation planning, models imitate the travel patterns of people and/or goods so that they can be studied. Travel demand models are based upon the practical relationships between socioeconomic characteristics, land uses, and travel patterns. By approximating future travel patterns, models make it possible to assess the implications of growth with differing land uses, to compare alternative transportation solutions, and to provide a testing ground for changes in transportation policy. **Figure 1** shows the components and step involved with the development of the model.

Figure 1. Process to Develop Travel Demand Model



The Four-Step Model

For over half a century, what transportation professionals have referred to as the four-step model has been the primary tool for estimating future travel demand for transportation planning projects in the United States. These models use a series of calculations that determine trip characteristics based on assumed land use patterns, socio-economic data and transportation system parameters.

Four-step models were originally employed during the 1950’s to forecast the future demand for highway infrastructure, focusing on the predicted number of trips between regional activity centers. Overtime, the model has evolved to include non-automobile modes of travel and to address a number of transportation-related issues.

In a typical travel demand modeling process, a study area is divided into small geographic areas called Travel Analysis Zones (TAZ). TAZs can range in size from a few blocks in dense urban areas to several square miles in rural areas. A travel demand model is comprised of four sequential calculation sub-models – hence the four-step nomenclature. **(Figure 2)**

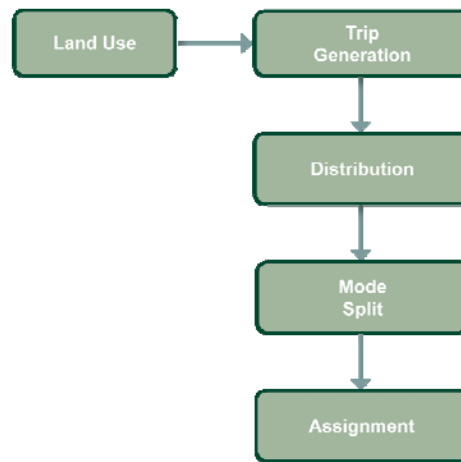
The four steps include:

1. Trip generation step estimates number of trips to and from all areas in the region
2. Trip distribution step links trips to and from all areas of the region
3. Mode Choice step estimates the modes people use to get their destinations
4. Route Assignment determines which route each vehicle will take to reach its destination

The Puget Sound Regional Council (PSRC) develops its regional model to assess regional trends in transportation within the Kitsap, King, Pierce and Snohomish county region. The current multi-modal PSRC model is capable of forecasting auto trips by occupancy, transit person trips, and pedestrian and bicycle trips. The PSRC networks contain the assumed highway infra-structure and transit service changes that are described in the regional transportation plan, *Destination 2030*. While this regional model is too coarse for a subarea analysis for the City of Des Moines, using the current PSRC modeling platform avoids the time and expense of constructing a new subarea model and provides consistency with the regional vision.

The Des Moines travel model contains demographic data sets, including household and employment forecasts, which are associated with a system of transportation analysis zones (TAZs). Household data consists of dwelling units of single family and multifamily categories. The employment data consists of jobs in retail, FIRES (finance, insurance, real estate and services), government and education, manufacturing and WTCU (wholesale, transportation, communications and utilities) sectors. Within the Des Moines Model, refinements were undertaken to allocate the existing and forecast land use to smaller areas within the City’s project study area,

Figure 2. Four-Step Travel Demand Model



Trip Generation

Person trips are the first step in the modeling process, before a determination is made of where they go (distribution), what mode they use (mode choice) or which route they take (trip assignment).

Trip generation rates are estimated using household and census surveys, which are performed periodically by PSRC for the Seattle region with the latest completed in 2006. Different trip rates are estimated for each trip purpose – e.g., work, shopping, social/entertainment, school. Trip generation rates on the home end can vary by the following characteristics of a household:

- Income
- Number of workers
- Vehicle availability

Trip generation rates per employee vary by employment type, breaking employment into six industry sector groups:

- Manufacturing
- Wholesale Trade, Transportation, Communications, and Utilities (WTCU)
- Retail Trade
- Finance, Insurance, Real Estate, and Services (FIRES)
- Government and
- Education

The trip generation model is the first of the four primary model components identified in the four-step modeling process. The trip generation model estimates the number of trips produced and attracted to each TAZ. The trips produced are estimated from households and their socioeconomic characteristics. The trips attracted are estimated from employment categorized by type.

Trip generation model was estimated using the 1999 household travel survey data in the Puget Sound region. These models were developed from 5,387 households in the survey, out of a total of 6,000 (90 percent) that was processed to ensure that the data were complete and logical, based on a series of validation tests. The models were estimated for each trip purpose separately. **Table 1** provides an overview of trip rates by purpose for households, persons and employees.

What are person trips?

The term “person trip” is a way to measure the number of people using a transportation facility. When person trips are identified for various modes – carpools or vanpools, transit or single occupant vehicles (SOVs) – mode shares can be analyzed.

A person trip represents each time a person leaves their origin (e.g. home) and arrives at their destination (e.g. work).

Numerous combinations of trips are analyzed in the model process (including work, shop, school, social/entertainment, etc.). The destination for each trip may vary, depending on what type of trip it is, travel time and cost in each scenario. For example, the trip from home to work is a person trip and the return trip from work to home is a second person trip.

Table 1. Trip Rates by Purpose

Trip Purpose	Trips Per Household	Trips Per Person	Trips Per Employee
Home-Based Work	1.55	0.61	1.13
Home-Based College	0.08	0.03	0.06
Home-Based School	0.69	0.27	0.51
Home-Based Shop	1.11	0.44	0.82
Home-Based Other	3.44	1.35	2.53
Non-Home-Based Work	0.88	0.34	0.65
Non-Home-Based Other	2.16	0.85	1.59
Total Person Trips	9.91	3.88	7.27

The trip generation model produces estimates for seven trip purposes:

1. Home-based work
2. Home-based college
3. Home-based school
4. Home-based shop
5. Home-based other
6. Non-home-based work
7. Non-home-based other

Fehr and Peers updated the home-based and non-home-based trip production and attraction models using the 1999 household travel surveys¹. Trip purposes are defined by the activities reported in the household survey at the origin and destination of each trip. If a person's trip has one end at home and one end at work with no stops in between, then this trip is defined as a home-based work trip. If a person's trip begins at home, then involves stopping at the store to buy groceries and continues on to work, this set of trips is defined as a home-based shopping trip and a non-home-based trip. Home-based other trips include activities for visiting, free-time, personal business, and appointments. Non-home-based trips include any trips that begin and end at places other than home.

Trip Distribution

The trip distribution model is the second of the four primary model components identified as part of the four-step modeling process. The trip distribution models estimate the number of trips from each TAZ to each other TAZ. The trips are estimated as a function of the travel impedance from one zone to another.

¹ Puget Sound Regional Council, 1999 *Household Travel Survey, Puget Sound Region*, July to November 1999.

Results from the trip distribution model are shown as trip tables by purpose. These can be summarized by the average trip length in both miles (distance) and minutes (travel time). **Table 2** presents a summary of the trip distribution results for the daily trip tables. Average speeds are calculated from the distance and travel time for each purpose. Changes in trip distance reflect changes in chosen routes due to congestion, and changes in travel time reflect changes in chosen routes, as well as changes in time caused by the congestion.

Table 2. Summary of Trip Distribution Results

Daily	Trips	Average Trip Length		Average Speed
		Miles	Minutes	
Home-based work				
Income less than \$25,000	146,924	9.01	20.12	26.9
Income \$25,000-\$45,000	345,518	11.33	23.95	28.4
Income \$45,000-\$75,000	640,106	12.64	26.01	29.2
Income more than \$75,000	851,933	13.42	26.78	30.1
Subtotal	1,984,481	12.50	25.58	29.3
Home-based college	98,030	9.15	19.84	27.7
Home-based school	883,724	4.06	11.54	21.1
Home-based shop	1,427,492	6.17	13.72	27.0
Home-based other	4,418,377	6.61	15.10	26.3
Non-Home-Based Work	1,129,434	6.26	14.11	26.6
Non-Home-Based Other	2,774,412	7.08	14.88	28.5
Total Person Trips	12,715,950	7.39	16.23	27.3

Mode Choice

The modal choice model is the third stage of the four-step travel demand modeling process. The mode choice steps considers trip variables such as auto operating costs, transit fares, routes, travel time, waiting time and parking costs, to estimate how many trips will be made by single occupant auto, carpool, local bus, express bus and rail transit. For all transit trips, the model also estimates how many people will walk and how many people will drive to get to the transit stop.

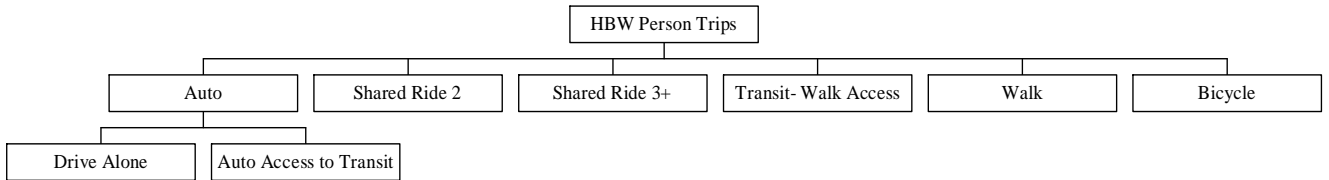
Mode choice models are used in the analysis of policy-oriented transportation planning scenarios and in examining the effects of various policy measures, as well as changes in the socioeconomic composition of an urban area on transportation-related social and environmental issues. A wide range of transportation policies can be evaluated through the application of the behavioral-based mode choice models. Examples include scenarios evaluating the effectiveness of high-occupancy vehicle (HOV) lanes, toll-ways, fixed guideway transit, exclusive bus lanes, and parking pricing.

Internally, the nested logit model for the home-based work trips addresses the following modes of transportation based on the AM peak roadway and transit travel times and level of transit service:

- Drive alone - Single-occupancy auto trips
- Shared ride 2 - Double-occupancy auto trips
- Shared ride 3+ - Auto trips with three or more occupants
- Transit - Walk access
- Transit - Auto access
- Bicycle
- Walk

The nesting structure of the nested multinomial logit model used for the home-based work trip purpose is presented in **Figure 3**.

Figure 3. Nesting Structure of the Home-Based Work Mode Choice Model



The mode choice model produces trips by various modes. The outputs of the model in the format of zone-to-zone travel movements by transit and highway modes are then assigned onto the highway and transit network for further analysis. **Table 3** presents the average vehicle occupancies for auto modes based on 2000 data. A regional summary of trips by various modes and trip purposes produced by the mode choice model for 2000 conditions is shown in **Table 4**.

Table 3. Regional Auto Occupancies (2000)

Trip Purpose	Total Trips
Home-Based Work	1.05
Home-Based College	1.09
Home-Based School	2.48
Home-Based Non-Work	1.45
Non-Home-Based	1.36
Total	1.36

Appendix A: Travel Model Background



Table 4. Regional Person Trips (2000)

Trip Purpose	Drive Alone	Shared Ride 2	Shared Ride 3+	Transit Walk	Transit Auto	Walk	Bicycle	Total
Home-Based Work	1,574,751	124,051	25,196	139,798	32,839	56,515	31,329	1,984,479
	79.4%	6.3%	1.3%	7.0%	1.7%	2.8%	1.6%	
Home-Based College	54,062	10,635		19,121		8,324	5,887	98,030
	55.1%	10.8%		19.5%		8.5%	6.0%	
Home-Based School*	20,779	135,332	217,786			509,826		883,724
	2.4%	15.3%	24.6%			57.7%		
Home-Based Non-Work	2,571,845	1,697,123	1,183,116	111,337		297,597	60,106	5,921,123
	43.4%	28.7%	20.0%	1.9%		5.0%	1.0%	
Non-Home-Based	1,937,757	962,933	645,323	81,587		268,151	28,028	3,923,779
	49.4%	24.5%	16.4%	2.1%		6.8%	0.7%	
Total	6,159,195	2,930,074	2,071,420	351,842	32,839	1,140,413	125,350	12,811,134
	48.1%	22.9%	16.2%	2.7%	0.3%	8.9%	1.0%	

*Walk and bicycle trips combined.

Trip Assignment

The trip assignment mode, the last of the four primary model components, determines the fastest paths or routes for trips between zones and assigns the traffic volume or transit ridership to those routes. The trip assignment model estimates the volume on each link in the transportation system for both highway and transit modes and considers the likely effect of congestion and delays on the most heavily-used facilities and diverts trips to other, less congested links. The trip assignment model generates specific performance measures, such as the congested speed or travel time on a highway link or the boardings and alightings on a transit route. Trip assignment is performed separately for each mode (auto and transit) and time period (AM peak, off-peak, PM peak, evening and night).

TRAVEL FORECAST METHODOLOGY

The travel model uses geographic areas for the estimates and analysis. For the City of Des Moines, the travel forecasting model study area consists of 58 transportation analysis zones (TAZs) as the basic geographic unit for estimating travel demand as described in the section above (Land Use Development). The model includes data for the entire Puget Sound Region in order to accurately analyze the impact of regional traffic on the City.

For the model, the City roadway and intersection characteristics are updated to reflect the city conditions. Initially, the model's trip purposes, trip generation rates and trip distribution parameters were based on those of the Puget Sound Regional Council (PSRC) surveys and parameters used in other travel models in the region. These were adjusted as part of the validation process. The final model validation procedure calibrated the base year model to the 2008 PM peak hour traffic counts, which had been collected as part of the transportation planning effort.

Future Des Moines Street Network

In order to address the growing traffic volumes and congestion levels on City streets, two future roadway improvement scenarios were examined: the Baseline without SR 509 and the Baseline with SR 509. While the Baseline without SR 509 represents a minimum level of roadway improvements, the Baseline with SR 509 project represents a level of roadway improvements listed for SR 509 extension and associated projects.

The 2030 Baseline scenario represents the traffic conditions assuming the street network with the projects committed to date. The Baseline network consists primarily of the existing City street system, funded projects programmed in the City's *Six Year Transportation Improvement Program (TIP) 2008-2013* and the State's Highway Program. The projects in **Table 5** are assumed to be in place by 2030 as part of the region's baseline traffic model and street system. Most of these projects are at least partially funded and have a reasonable likelihood of being implemented during the next 20 years. This set of projects provides a frame of reference for examining the performance of the City street system in 2030.

Table 5. Future Baseline Projects

	Project	Description
Regional Projects		
1	SR 167 – I-405 to SR 18	Add one travel lane in each direction
2	I-5 – SR 509 Extension to S 277th Street	Add travel lanes for merging traffic to/from SR 509 Extension
3	SR 509 Extension – SR 518 to I-5	Construct new freeway extension from Sea-Tac Airport to I-5
4	I-405 – I-5 to Bellevue	Add travel lanes (funded by WSDOT gas tax projects)
City of Des Moines Projects		
1	South 216th Street Improvement-Phase 1	From Pacific Highway South to 24th Avenue South –Widens from three lanes to five lanes roadway.
2	South 216th Street Improvement-Phase 2	From 24th Avenue South to 20th Avenue South – Widens from two lanes to five lanes roadway.
3	South 216th Street Improvement-Phase 3	From 20th Avenue South to 11th Avenue South – Widens from two lanes to three lanes roadway.
4	South 216th Street Improvement-Phase 4	From Marine View Drive to 11th Avenue South –Widens from two lanes to three lanes roadway.
5	24th Avenue South Improvement-Phase 1	From South 216th Street to Kent-Des Moines Road –Widens from two lanes to two-three lanes roadway.
6	24th Avenue South Improvement-Phase 2	From South 208th Street to South 216th Street –Widens from two lanes to five lanes roadway.
7	16th Avenue South Improvement-Phase 3	From Kent-Des Moines Road to South 240th Street – Widens from two lanes to three lanes roadway.
8	16th Avenue South Improvement-Phase 4	From South 240th Street to South 250th Street – Widens from two lanes to three lanes roadway.
9	16th Avenue South Improvement-Phase 5	From Pacific Highway South to South 272nd Street – Widens from two lanes to three lanes roadway.
10	Kent-Des Moines Road Improvement-Phase 1	From 16th Avenue South to 24th Avenue South – Widens from two lanes to three lanes roadway.
11	Kent-Des Moines Road Improvement-Phase 2	From 24th Avenue South to Pacific Highway South – Widens from two lanes to five lanes roadway.
12	Kent-Des Moines Road Improvement-Phase 3	From Marine View Drive to 16th Avenue South – Widens from two lanes to three lanes roadway.

A summary of Des Moines trips by various modes and trip purposes produced by the mode choice model for existing conditions, 2030 Baseline without SR 509 project and 2030 Baseline with SR 509 project are shown in **Table 6, 7 and 8.**

Table 6. Existing Des Moines Person Trips (2008)*

Trip Purpose	Drive Alone	Shared Ride		Transit		Walk	Bicycle	Total
		2	3+	Walk	Auto			
Home-Based Work	713	44	9	257	51	113	61	1,248
	57.14%	3.53%	0.69%	20.59%	4.12%	9.06%	4.86%	
Home-Based College	119	21		41		7	18	206
	57.78%	10.30%		19.78%		3.37%	8.77%	
Home-Based School^	193	630	830			5,078		6,731
	2.9%	9.4%	12.3%			75.4%		
Home-Based Non-Work	3,344	2,411	1,740	335		774	123	8,728
	38.3%	27.6%	19.9%	3.8%		8.9%	1.4%	
Non-Home-Based	2,055	1,005	669	165		421	38	4,353
	47.2%	23.1%	15.4%	3.8%		9.7%	0.9%	
Total	6,425	4,111	3,248	798	51	6,394	240	21,267
	30.2%	19.3%	15.3%	3.8%	0.2%	30.1%	1.1%	

*2008 Person Trips based on 2006 PSRC data.

^Walk and bicycle trips combined.

Table 7. Des Moines Person Trips (2030 Baseline without SR 509)

Trip Purpose	Drive Alone	Shared		Transit		Walk	Bicycle	Total
		Ride 2	Ride 3+	Walk	Auto			
Home-Based Work	1,328	84	17	557	86	254	133	2,460
	54.00%	3.42%	0.68%	22.66%	3.51%	10.34%	5.41%	
Home-Based College	119	21		41		9	22	213
	55.96%	9.94%		19.26%		4.38%	10.46%	
Home-Based School*	212	691	911			5,582		7,397
	2.9%	9.3%	12.3%			75.5%		
Home-Based Non-Work	5,918	4,104	3,049	1,058		1,782	265	16,177
	36.6%	25.4%	18.9%	6.5%		11.0%	1.6%	
Non-Home-Based	4,902	2,401	1,599	727		1,404	119	11,152
	44.0%	21.5%	14.3%	6.5%		12.6%	1.1%	
Total	12,480	7,302	5,576	2,383	86	9,033	539	37,399
	33.4%	19.5%	14.9%	6.4%	0.2%	24.2%	1.4%	

*Walk and bicycle trips combined.

Table 8. Des Moines Person Trips (2030 Baseline with SR 509)

Trip Purpose	Drive Alone	Shared		Transit		Walk	Bicycle	Total
		Ride 2	Ride 3+	Walk	Auto			
Home-Based Work	1,253	79	16	481	55	215	115	2,215
	56.57%	3.59%	0.71%	21.70%	2.50%	9.73%	5.19%	
Home-Based College	126	22		39		9	21	218
	57.92%	10.29%		17.98%		4.01%	9.80%	
Home-Based School*	210	685	902			5,526		7,323
	2.9%	9.4%	12.3%			75.5%		
Home-Based Non-Work	6,063	4,220	3,133	953		1,622	241	16,232
	37.4%	26.0%	19.3%	5.9%		10.0%	1.5%	
Non-Home-Based	4,994	2,447	1,630	626		1,223	102	11,022
	45.3%	22.2%	14.8%	5.7%		11.1%	0.9%	
Total	12,647	7,454	5,680	2,098	55	8,595	479	37,010
	34.2%	20.1%	15.3%	5.7%	0.1%	23.2%	1.3%	

*Walk and bicycle trips combined.

Des Moines Land Use Development

Base year estimates for housing and employment were developed using the latest PSRC databases available.² Housing data were developed using building permit data provided by PSRC and the US Census Bureau. Employment data were developed using Washington State Employment Security data as processed by the Puget Sound Regional Council. The base year estimates of housing and employment are key inputs to the refined Des Moines transportation model.

Des Moines Zone Structure

With guidance from Des Moines staff, transportation analysis zones (TAZ's) were developed for the Des Moines travel demand model. A total of 58 internal zones were created to provide information for Des Moines and a few of the zones adjacent to City (See **Figure 4**). The final Des Moines zone structure was aggregated to the 19 TAZ of the PSRC covering the City and its vicinity as defined by PSRC. This zone change affects the ability of modelers to quickly summarize data for the City road network.

Housing

Staff initially developed estimates of base year housing units using census block data for year 2000, found in Summary File 1 (SF 1) and adding the growth information provided by PSRC for the following 6 years. In general, the Des Moines zone structure has a correlation to census block geography. To the degree possible, census tract housing unit totals (single family, multi-family and mobile homes) were used as the universe for the Des Moines TAZ that makes up the census tract. The PSRC collects building permit records from all jurisdictions and converts the data into point level geometry. Modelers put the point level data over the Des Moines TAZ system to determine the growth in housing units.

The housing unit data was then converted to households. Housing units and households data from SF1 was used to determine an occupancy estimate for the Des

Where did the land use forecasts come from?

The land use forecasts used in the city of Des Moines model are derived from regional forecasts prepared by the PSRC who develops forecasts for the four-county region. PSRC coordinates this effort regionally and has done so for over three decades.

Over this time period of time, PSRC has updated their regional models every 2 to 5 years advancing their methods of forecasting land use by incorporating actual trends and historic data regarding growth in each on-going update.

By updating conditions periodically, the PSRC modelers are able to adjust forecasts to trends that are relative to the region. At any point in time their land use projection represents the best available data set for transportation analyses, understanding that the refinement of forecasts is an on-going task. The regional land use models are not typically re-run for every project or analysis.

² PSRC housing and employment data is based on 2006 data. The development of the 2008 Des Moines model assumed the 2006 PSRC data was representative of 2008 housing and employment conditions within the City.

Moines zones. Multiplying the estimated housing units within a TAZ by the occupancy rate gives an estimate of total households. The initial estimate of housing units and households were reviewed and agreed to by Des Moines staff.

Future year (2030) household forecasts were initially developed using the latest household estimates adopted by the Puget Sound Regional Council. The development of the year 2030 housing data was based on the Des Moines base year distribution and the growth assumed in the PSRC forecasts. Des Moines staff reviewed the 2030 estimated forecasts and recommended some modifications based on the City's latest buildable lands analysis.

The Des Moines TAZs are a subset of a series of census tracts (285 to 292, 294, 297 to 300). **Figure 5** shows the graphical correlation between PSRC TAZs and Des Moines TAZs.

Figure 4. PSRC TAZs for the City of Des Moines

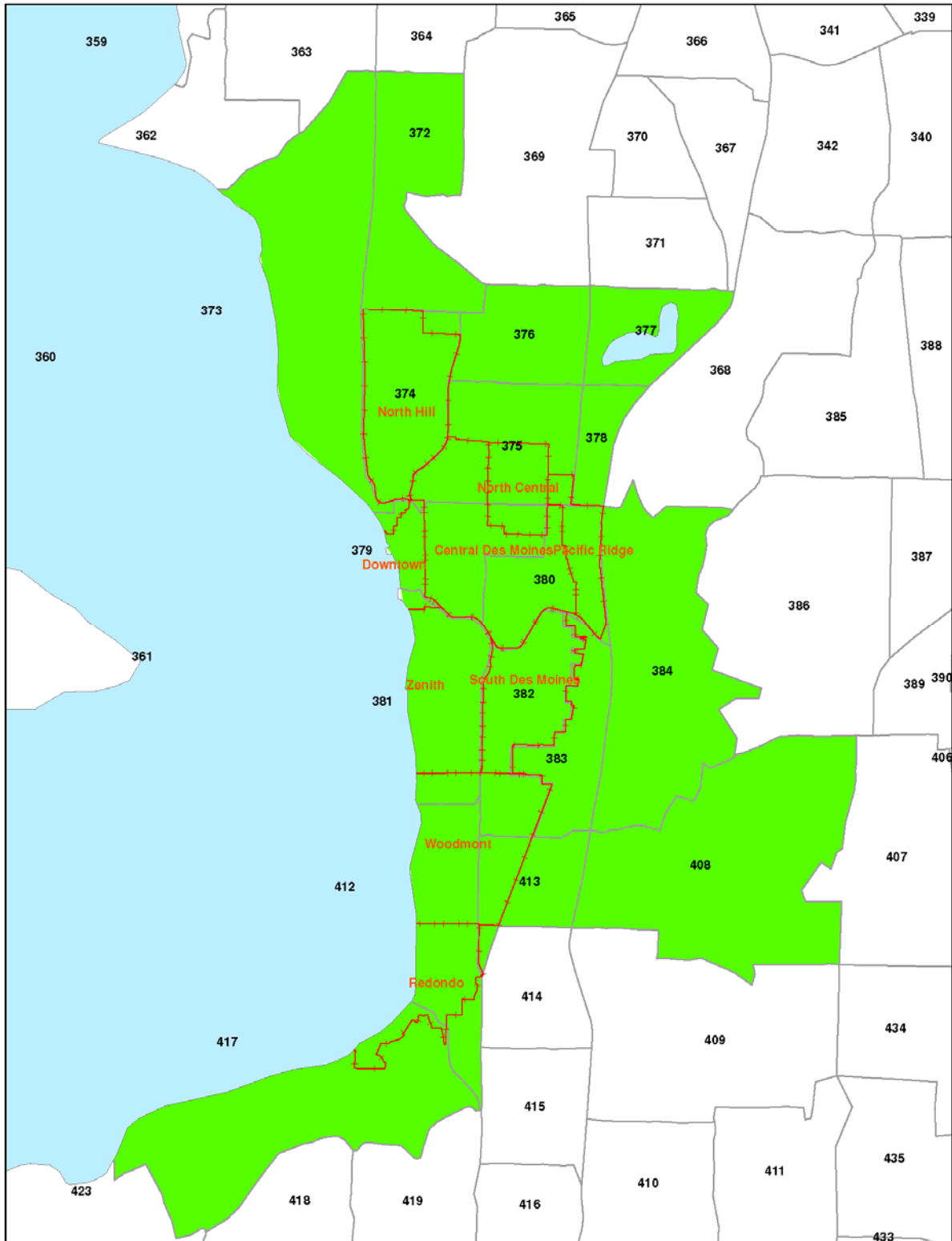


Figure 5. Des Moines TAZs Overlayed on PSRC TAZs

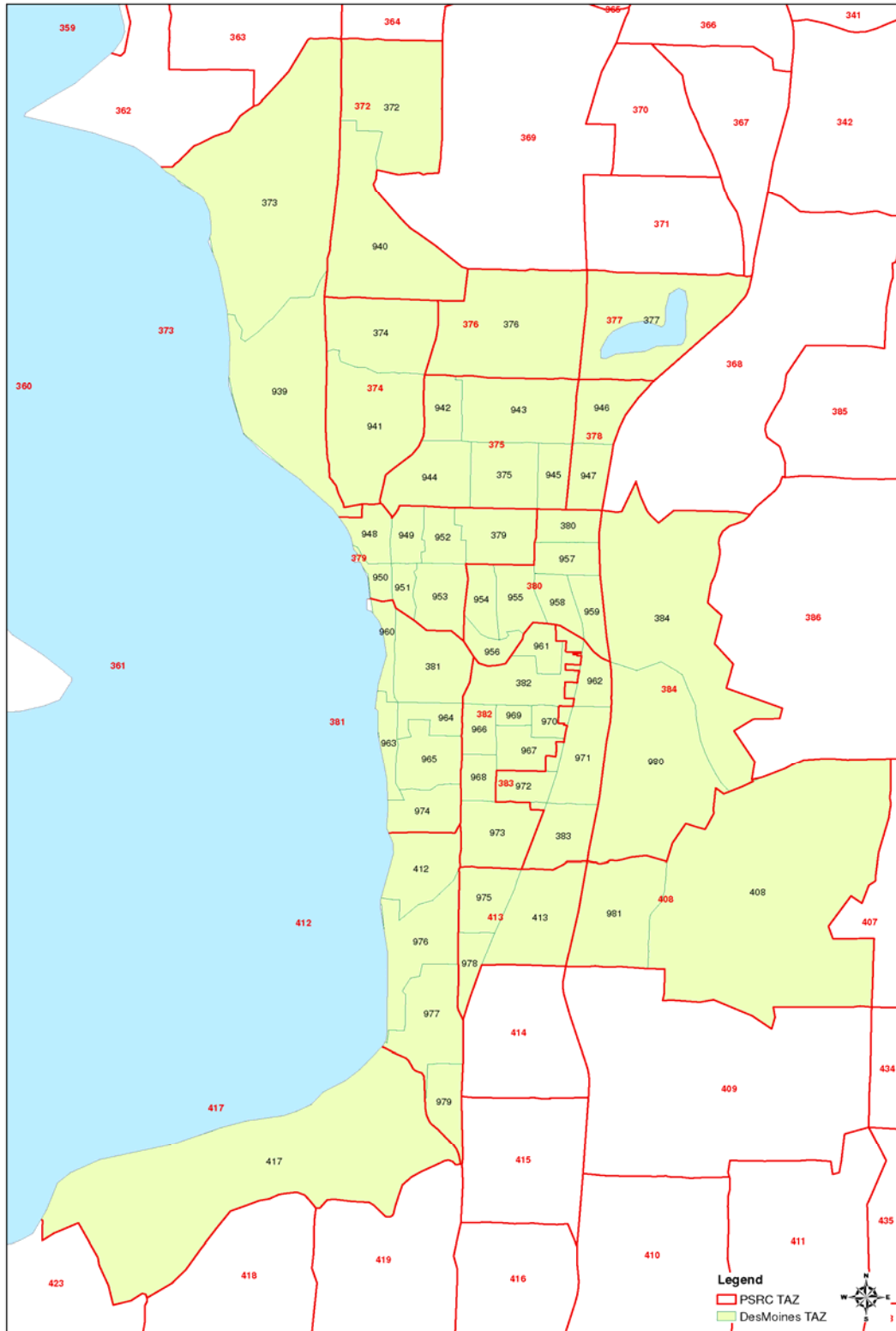


Table 9 shows the results of the methodology that created base year estimates of housing units and households in Des Moines TAZs within census tracts defining the study area.

Table 9. Sample of Land Use Data for 2008 Base Year

Des Moines TAZ	2000 Housing Units	2000 Households	2000 Vacancy Rate	Growth in Housing Units	2008 Housing Units*	2008 Households*
372	538	428	0.8	43	581	462
373	1952	1906	0.98	118	2070	2021
374	709	695	0.98	4	713	699
939	669	652	0.97	16	685	668
940	1197	1155	0.96	8	1205	1163
941	1237	1211	0.98	9	1246	1220
942	263	259	0.98	12	275	271
943	357	332	0.93	-7	350	325
944	350	333	0.95	-1	349	332

*2008 housing unit data analysis based on 2006 PSRC data.

Employment

Estimates of base year employment data were developed using the year 2006 Washington State Employment Security data. The employment data which includes those employees covered by the Washington Unemployment Insurance Act, typically accounts for 85 to 90 percent of the total employment in a region. The Puget Sound Regional Council in accordance with agreements between the Washington State Employment Security Department, and the City of Des Moines processed the initial dataset.

The final zonal estimates are summarized into six groups of employment sectors and then factored to develop full employment in a zone. The employment sectors include Retail, FIRES (Finance, Insurance, Real Estate and Services), Government, Education, Manufacturing and WTCU (Wholesale, Transportation, Communication and Utilities). The estimates provide the distinct distribution of employment within the City of Des Moines. City staff reviewed and agreed to the initial estimates of total employment.

Fehr and Peers developed future year employment initial estimates using the PSRC database for year 2030. The PSRC TAZ employment was distributed into Des Moines TAZ based on the proportions from base year employment. Des Moines staff reviewed the initial estimated forecasts for year 2030 and recommended some modifications based on current development patterns and local knowledge. The modelers used the estimates provided by the City for the Des Moines transportation model development. **Tables 10, 11 and 12** show estimates for households and employment by Des Moines TAZ.

Table 10. Households and Employment Estimates Summary (2006 and 2030)

Des Moines TAZ	2008 Households*	2008 Employment*	2030 Households	2030 Employment
372	462	87	550	523
373	2021	484	2198	1032
374	699	311	818	312
375	0	0	0	1317
376	68	2322	81	2887
377	1164	1007	1325	3872
379	273	44	418	72
380	625	133	2519	1344
381	542	300	1055	301
382	419	961	446	1093
383	816	258	989	619
384	860	181	886	222
408	2312	575	2933	1364
412	435	8	498	8
413	473	221	571	384
939	668	106	726	149
940	1163	1247	1384	2745
941	1220	31	1276	32
942	271	4	323	6
943	325	486	387	581
944	332	268	375	350
945	32	16	32	737
946	915	325	1162	341
947	334	494	424	598
948	326	266	511	524
949	168	473	223	553
950	186	196	371	456
951	102	118	204	241
952	192	127	219	127
953	264	6	295	6
954	138	26	149	26
955	124	154	144	179
956	350	1	385	1
957	440	468	1400	843
958	357	214	557	1396
959	496	228	1636	692
960	276	134	288	134
961	397	148	397	183
962	178	289	216	590

Appendix A: Travel Model Background

Des Moines TAZ	2008 Households*	2008 Employment*	2030 Households	2030 Employment
963	91	3	103	3
964	202	9	214	9
965	604	6	617	6
966	212	10	221	10
967	191	127	191	171
968	119	6	133	6
969	68	6	95	6
970	199	41	222	66
971	51	305	62	433
972	268	35	325	72
973	512	96	571	109
974	72	2	82	2
975	265	57	349	95
976	338	40	405	41
977	286	97	577	97
978	153	396	153	396
979	343	132	411	151
980	1501	191	1547	523
981	646	72	819	176
	26544	14348	35468	29212

*2008 housing unit/employment data based on 2006 PSRC and 2006 Washington State Employment Security data.

Table 11. Employment Estimates 2008*

Des Moines TAZ	RETAIL	FIRES	Adj Gov	EDUC	WTCU	Adj Man
372	57	27	3	0	0	0
373	96	323	0	55	10	0
374	11	98	0	48	140	14
375	0	0	0	0	0	0
376	46	1038	24	0	1213	1
377	22	721	152	0	93	19
379	0	1	3	0	40	0
380	29	62	0	0	42	0
381	0	296	0	0	4	0
382	22	60	0	872	7	0
383	155	85	0	0	0	18
384	121	19	0	19	22	0
408	11	388	5	136	30	5
412	0	6	0	0	2	0
413	98	103	20	0	0	0
939	3	64	0	38	1	0
940	29	428	55	15	576	144
941	0	27	0	0	2	2
942	0	2	0	0	2	0
943	8	307	0	0	138	33
944	7	261	0	0	0	0
945	13	3	0	0	0	0
946	11	186	0	52	76	0
947	144	285	0	0	65	0
948	52	193	0	0	19	2
949	19	402	10	33	7	2
950	50	134	11	0	0	1
951	31	73	0	0	4	10
952	0	0	126	0	1	0
953	0	6	0	0	0	0
954	0	26	0	0	0	0
955	0	3	22	129	0	0
956	0	1	0	0	0	0
957	0	404	19	42	3	0
958	56	94	0	0	64	0
959	12	215	0	0	1	0
960	13	119	0	0	2	0
961	6	137	4	0	1	0
962	38	215	0	0	36	0
963	0	3	0	0	0	0
964	0	5	0	0	4	0
965	0	6	0	0	0	0

Appendix A: Travel Model Background

Des Moines TAZ	RETAIL	FIRES	Adj Gov	EDUC	WTCU	Adj Man
966	0	10	0	0	0	0
967	0	73	0	43	9	2
968	0	6	0	0	0	0
969	0	6	0	0	0	0
970	30	10	1	0	0	0
971	10	40	0	0	53	202
972	18	17	0	0	0	0
973	27	59	0	0	0	10
974	0	2	0	0	0	0
975	0	24	0	33	0	0
976	21	3	16	0	0	0
977	6	90	0	0	1	0
978	209	168	16	0	0	3
979	10	109	0	0	9	4
980	2	149	0	39	1	0
981	7	19	5	0	41	0

*Employment data based on 2006 Washington State Employment Security data.

Table 12. Employment Estimates 2030

Des Moines TAZ	RETAIL	FIRES	Adj Gov	EDUC	WTCU	Adj Man
372	407	114	2	0	0	0
373	519	391	38	78	6	0
374	30	131	0	84	61	6
375	187	1130	0	0	0	0
376	216	757	35	0	1879	0
377	106	3601	0	0	157	8
379	0	1	4	0	67	0
380	418	494	0	0	432	0
381	0	297	3	0	1	0
382	209	341	0	510	33	0
383	426	182	0	0	0	11
384	90	53	0	30	49	0
408	219	944	5	180	16	0
412	0	2	0	0	6	0
413	228	155	1	0	0	0
939	18	77	0	53	1	0
940	207	1791	41	23	497	186
941	0	30	0	0	1	1
942	0	3	0	0	3	0
943	53	320	10	0	162	36
944	50	300	0	0	0	0
945	709	28	0	0	0	0
946	13	262	0	28	38	0
947	163	402	0	0	33	0
948	217	269	0	0	35	3
949	61	433	11	35	10	3
950	230	207	17	0	0	2
951	122	95	0	0	8	16
952	0	0	125	0	2	0
953	0	6	0	0	0	0
954	0	26	0	0	0	0
955	0	3	19	157	0	0
956	0	1	0	0	0	0
957	0	696	32	98	7	10
958	509	477	0	0	410	0
959	64	624	0	0	4	0
960	54	80	0	0	0	0
961	3	48	132	0	0	0
962	97	427	46	0	20	0
963	0	3	0	0	0	0
964	0	8	0	0	1	0
965	0	6	0	0	0	0

Des Moines TAZ	RETAIL	FIRES	Adj Gov	EDUC	WTCU	Adj Man
966	0	10	0	0	0	0
967	0	147	0	8	15	1
968	0	6	0	0	0	0
969	0	6	0	0	0	0
970	26	5	35	0	0	0
971	62	191	0	0	36	144
972	41	31	0	0	0	0
973	45	61	0	0	0	3
974	0	2	0	0	0	0
975	0	36	0	59	0	0
976	36	1	4	0	0	0
977	35	55	0	0	7	0
978	255	134	0	0	5	2
979	50	52	0	0	45	4
980	2	411	43	62	2	3
981	112	40	5	0	19	0

Existing Model Validation

Model validation is a method used to match the known land use data to the existing traffic count data. The validated model then ready to for forecasting future travel demand based on changes in land use. The Des Moines model with the estimated base year land use data as an input was used to get the estimated trip volumes. The model volumes were validated against the observed data at a set of screenlines defining the study area. **Table 13** provides the initial demand estimates before calibration. Modelers used the initial model validation data to refine and calibrate the existing model to match the observed data better. Multiple model runs were performed to have the final calibrated model match the observed data better.

The final validated model includes a number of refinements including speed changes to reflect the existing conditions rather than the posted speed, and the weighting and placement of centroid connectors reflect the existing driveways and access points. **Table 14** provides the citywide demand estimates with all the enhancements incorporated based on the independent review and recommendations. The screenline summaries with the recommended enhancements match the observed data better than the estimates that were initially developed.

Traffic Forecasts

The validated model is used with the 2030 land use to forecast the future traffic volumes. The 2030 model for the City follows the four-step process (trip generation, distribution, mode split and assignment) to estimate the future 2030 traffic volumes on the future street network. A post-processing step is used to adjust the model

volumes to reflect any differences previously between the base year observed and model volumes. The resulting volumes are used to analyze future traffic conditions and to identify any needed system improvements.

Table 13. Observed and Estimated Existing (2008) PM Peak Hour Volumes-City of Des Moines (Before Validation)

	Observed Volumes		Model Volumes		Ratio (Model/Observed)	
	EB	WB	EB	WB	EB	WB
Screenline 1, East of SR99 - Pacific Highway	3,695	3,705	4,544	3,915	23.0%	5.7%
	NB	SB	NB	SB	NB	SB
Screenline 2, South of S 272nd St	1,130	2,720	1,125	2,363	-0.4%	-13.1%
	NB	SB	NB	SB	NB	SB
Screenline 3, North of S 216th St	7,990	12,890	9,526	15,052	19.2%	16.8%
	NB	SB	NB	SB	NB	SB
Screenline 4, North of S 223rd St	1,620	3,350	2,096	3,906	29.4%	16.6%
	NB	SB	NB	SB	NB	SB
Screenline 5, South of S 240th St	7,070	11,600	7,615	12,822	7.7%	10.5%
	EB	WB	EB	WB	EB	WB
Screenline 6, West of SR99- Pacific Highway	2,105	2,275	1,470	1,661	-30.2%	-27.0%
	EB	WB	EB	WB	EB	WB
Screenline 7, East of Marine View Drive	1,780	1,915	1,204	1,425	-32.4%	-25.6%
	NB	SB	NB	SB	NB	SB
Screenline 8, North of Kent Des Moines Road	7,000	11,420	9,095	14,313	29.9%	25.3%
	NB	SB	NB	SB	NB	SB
Screenline 9, I-5 Interchange at Kent Des Moines Road	6,360	11,420	8,026	12,363	26.2%	8.3%
Total	38,750	61,295	44,701	67,820	15.4%	10.6%

Table 14. Observed and Estimated Existing (2008) PM Peak Hour Volumes – City of Des Moines (After Validation)

	Observed Volumes		Model Volumes		Ratio (Model/Observed)	
	EB	WB	EB	WB	EB	WB
Screenline 1, East of SR99 - Pacific Highway	3,695	3,705	4,118	3,794	11.4%	2.4%
	NB	SB	NB	SB	NB	SB
Screenline 2, South of S 272nd St	1,130	2,720	1,336	2,540	18.2%	-6.6%
	NB	SB	NB	SB	NB	SB
Screenline 3, North of S 216th St	7,990	12,890	8,676	13,167	8.6%	2.1%
	NB	SB	NB	SB	NB	SB
Screenline 4, North of S 223rd St	1,620	3,350	1,798	3,121	11.0%	-6.8%
	NB	SB	NB	SB	NB	SB
Screenline 5, South of S 240th St	7,070	11,600	6,908	11,341	-2.3%	-2.2%
	EB	WB	EB	WB	EB	WB
Screenline 6, West of SR99- Pacific Highway	2,105	2,275	1,789	1,837	-15.0%	-19.3%
	EB	WB	EB	WB	EB	WB
Screenline 7, East of Marine View Drive	1,780	1,915	1,526	1,816	-14.3%	-5.2%
	NB	SB	NB	SB	NB	SB
Screenline 8, North of Kent Des Moines Road	7,000	11,420	7,835	12,004	11.9%	5.1%
	NB	SB	NB	SB	NB	SB
Screenline 9, I-5 Interchange at Kent Des Moines Road	6,360	11,420	6,808	10,866	7.0%	-4.9%
Total	38,750	61,295	40,794	60,486	5.3%	-1.3%