replaced oil as the growth industry. During this period, the Denver regional economy diversified and moved away from being dependent on resource extraction.

The national recession of 2001 impacted Colorado (as well as the entire United States) and injected substantial economic uncertainty and slowed growth trends of the 1990s (Bloom 2007; Colorado Department of Labor and Employment 2002). However, the diversity of the economy helped the Denver region weather this downturn. Job losses were concentrated in five sectors: construction, technology, communications, travel and tourism, and temporary employment firms.

## 3. Current Conditions

The Denver Region is the economic hub for both the state of Colorado, and the larger Rocky Mountain Region. The economy is fairly diverse, with strengths in manufacturing, transportation, and high-tech industries. Agriculture is not a significant contributor to the local economy, although some production does take place. Mining is not prevalent in the region, although Denver County is home to the world's largest gold mining company. Although this company does not have current extraction operations in the state of Colorado, it provides significant employment. For this reason, a good portion of the state's mining jobs are located in the metro area (Wobbekind, et. al., 2004).

With Denver's central location in the United States, the area has long been a transportation hub. Trucking, warehousing, and air transportation have major presences in the region. The majority of the state's transportation jobs are found in Denver and Adams Counties. Expansion is expected in this area as a result of continued growth at DIA and the area reliever airports (Wobbekind, et. al., 2004).

The state's manufacturing industry is also centered in the metro area. Both new and old economy industries are present in the region. The area has strengths in general manufacturing, and also in photonics, computer hardware and storage, and software. Boulder, Broomfield, Denver, Adams, and Arapahoe counties have especially strong manufacturing industries, despite state and national trends that show declines in employment (Wobbekind, et. al., 2004).

The metro area serves as the regional center for health care and financial services. Parts of the region, especially Douglas and Broomfield Counties have experienced very rapid population growth and Adams County is expected to show strong growth in the next twenty years. As people continue to migrate to these areas, the demand for basic financial and health care services will increase, and these industries should experience growth. The strength of the area's biotech industry could also help to drive growth in the health care industry. Furthermore, the Denver area is recognized nationally as a hub for mutual funds, and as the economy recovers and investors regain confidence in the markets, this area could grow (Wobbekind, et. al., 2004).

Tourism is also an important part of the economy. The presence of the airport facilitates a good portion of tourism in the entire state. Denver is also a popular convention destination. The four major professional sports teams in Denver, along with the State Capital Building, the Denver Zoo, and the Museum of Natural History, help to attract visitors to the area. There are also numerous cultural and recreational tourist activities available in the area. Furthermore, while none of the state's major tourist attractions are located within the boundaries of the metro area, many of the state's tourists stay in the region, either with family members or at hotels, and then take day-trips to their various destinations (Wobbekind, et. al., 2004).

Overall, growth prospects for the regional economy look promising. As the national and state economies recover, the region should follow. The Denver metro area will continue to be the center of economic activity in the state, and the Rocky Mountain region (Wobbekind, et. al., 2004).

### *a. Employment*

Employment has grown substantially in the Denver region from 1950 to 2000, with particularly fast growth between 1970 and 1980 and between 1990 and 2000. As one indicator of this growth, **Figure 15** and **Figure 16** show the change in employment for various counties in the region as well as the region as a whole.

**Figure 15**
**Employment by County 1950-2000**

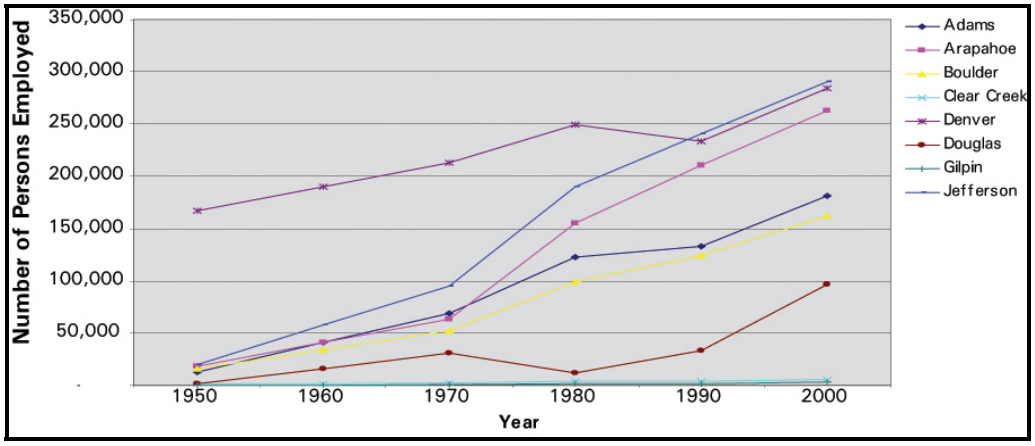
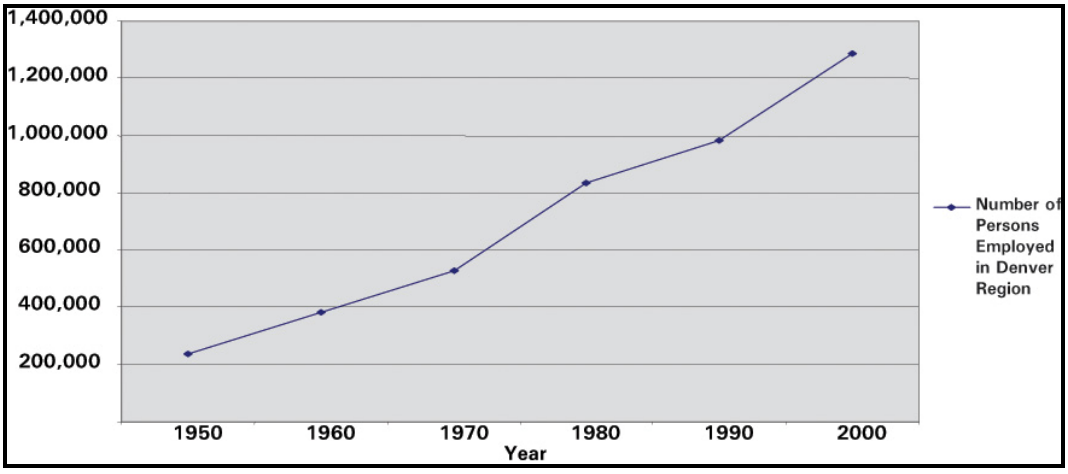



**Figure 16**
**Denver Area Employment 1950-2000**

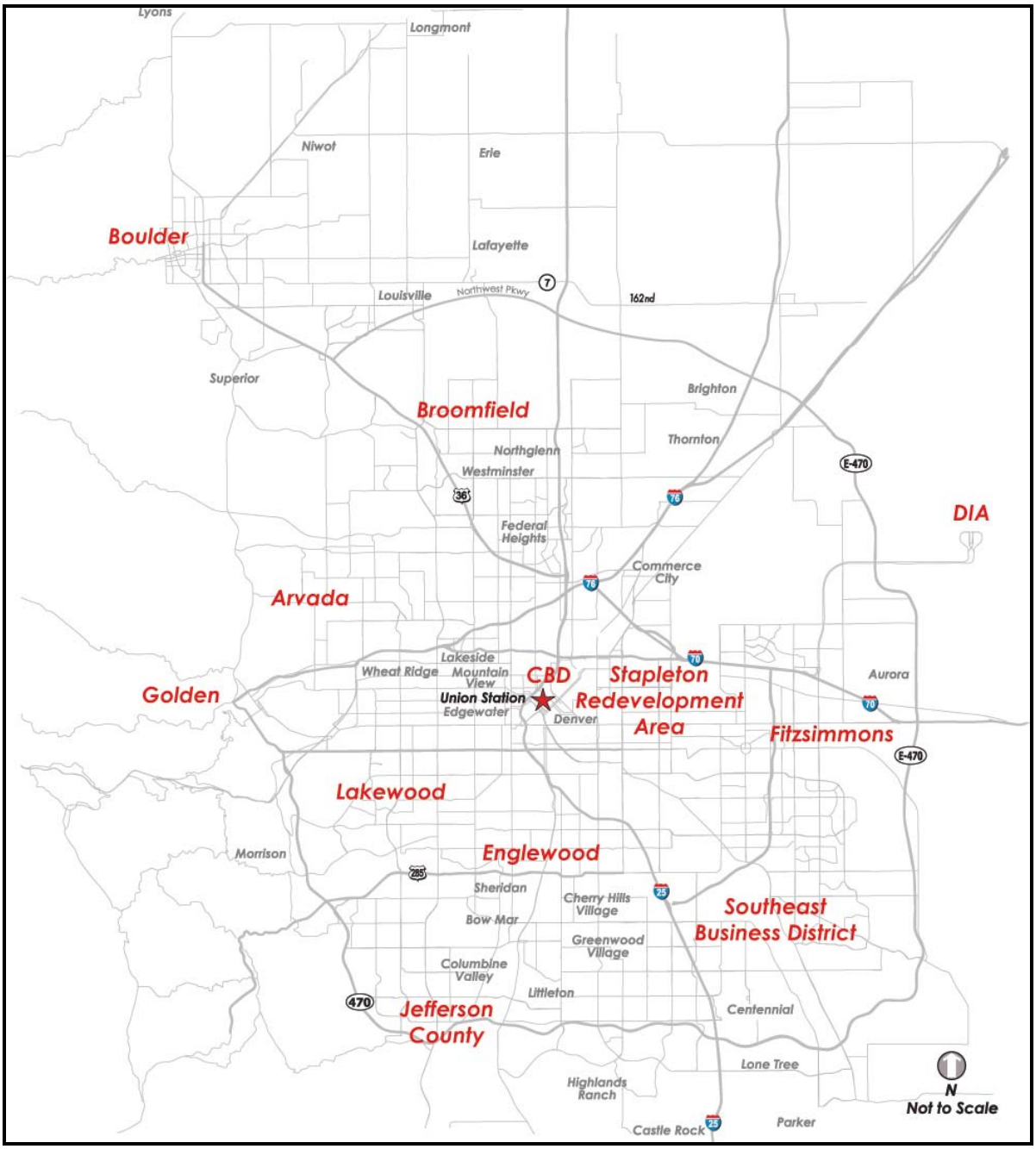



*Source: U.S. Census Bureau 2000. Employment numbers area based are from the 1950, 1970, 1980, 1990 and 2000 decennial censuses. Values were not available for the 1960 Decennial Census, for analytical purposes the 1960 value was interpolated.*

### *b. Major Employment Areas*

The region's major employment areas as defined by MetroDenver EDC are depicted in **Figure 17** and discussed below.

**Figure 17**
**Regional Employment Areas**



**Arvada**
Approximately 65,000 people are employed in Arvada (City of Arvada 2005). Major employment sectors are not identified. The top three employers (by number of employees) are Sorin Group USA, Inc. (450 employees), Sundyne Corporation (350 employees), and Pridemark Paramedic Services, LLC (280 employees) (Arvada Economic Development Association 2007).

**Boulder**
Approximately 98,400 people were employed in the city of Boulder in 2004 (City of Boulder 2007). Major employment sectors include software development, biosciences, computer storage and peripherals, natural and organic products, and aerospace (Boulder Economic Council 2007). Boulder has been losing jobs since the economic downturn in 2001 (City of Boulder 2005). However, the city has implemented an economic revitalization program in recent years.

**Broomfield (City and County)**
Approximately 24,000 people are employed in Broomfield (Broomfield Economic Development Corporation 2007). The City and County of Broomfield is strategically located in a high-tech growth area. It has been the area's high-tech employment hub for the last 50 years. The high-tech growth stems from its proximity to the University of Colorado's (CU) Boulder campus. The top employers (by number of employees) are Sun Microsystems (3,400), Ball Corporation (3,000), and Level 3 Communications (2,000).

**Denver Central Business District (CBD)**
The City of Denver is the largest employment area in the region. Approximately 300,000 people are employed in Denver (City and County of Denver 2005). The CBD's major employment sectors are trade/transportation/utilities, professional and business services, government, and education and health services (City of Denver 2005). The top three employers (by number of employees) are Qwest Communications (13,200), HealthONE (8,600), and King Soopers, Inc. (4,800) (City of Denver 2005). The city has the second largest number of college graduates per capita in the nation.

**Denver International Airport (DIA)**
Approximately 30,000 people are employed at DIA. DIA is one of the busiest airports in the U.S., serving 30 airlines (Denver International Airport 2007). In 2005, it served 43 million passengers (Denver International Airport 2005).

**Southeast Business District (including Denver Tech Center)**
This business district crosses several local government boundaries; therefore, employment data is not readily available for the Southeast Business District. The Denver Tech Center is located here, as is Greenwood Village, Inverness Business Park, Meridian Business Park, and the new city of Centennial. The Tech Center is Denver's second largest employment center with 1,000 companies and approximately 35,000 employees (City and County of Denver 2000). The area between the Southeast Business District and the Denver Central Business District is the most congested corridor in the region.

**Englewood**
Approximately 25,000 people are employed in the city of Englewood. There are six key industry clusters in Englewood: automotive, business support services, construction, life sciences,

manufacturing, and sporting goods (City of Englewood 2007). The top three employers (by number of employees) are Swedish Medical Center (1,800), Sports Authority (900), and Craig Hospital (650).

**Golden**
Approximately 18,000 people are employed in Golden. Major employment sectors are services, manufacturing, and retail trade. Top employers (by number of employees) are Coors Brewing Company, Jefferson County, and the Colorado School of Mines (City of Golden 2007). Golden is the county seat of Jefferson County.

**Jefferson County**
Approximately 247,000 people are employed in Jefferson County. Major employment sectors are services, government, and retail trade. The top three employers (by number of employees) are Denver Federal Center (6,000), Lockheed Martin Space and Strategic Missiles (5,500), and Exempla—Lutheran Medical Center (2,500) (Jefferson Economic Council 2007).

**Lakewood**
Fourteen businesses were identified as being in Lakewood and employing more than 250 employees; these 14 businesses had a total employment of 23,559 in March 2006. Major employment sectors are business services, construction trades, finance, insurance, real estate, and health insurance (City of Lakewood 2007a). The top three employers (by number of employees) are Jefferson County R-1 School District (11,000), Denver Federal Center (6,200), and Gambro (1,500) (City of Lakewood 2007b).

**Stapleton Redevelopment Area**
Denver's former international airport, Stapleton, is currently being redeveloped as a planned community including homes, businesses, parks and transportation opportunities. It encompasses approximately 4,700 acres of the former airport. Eight businesses are currently at Stapleton with the largest being the United Airlines Training Facility at Stapleton with 800 employees and Nobel/Sysco Food Services Company with 800 employees and plans for 200 additional employees (Forest City Enterprises 2007). The redevelopment plan for Stapleton calls for a variety of office and retail space.

### *c. Economic Base and Property/Land Values*

**Economic Base**
Telecommunications, technology and tourism are large drivers of Denver's economy. Government (federal, state and local) is Metro Denver's largest source of employment, followed by retail. In 2006, the top 24 public sector employers had 174,000 employees. The largest private employer in the Denver region is Qwest Communications with 9,500 employees, followed by King Soopers Inc. Retail Grocery Stores with 8,600 employees and HealthONE with 7,900 employees (MetroDenver EDC 2006b). In 2006, the top 20 private employers had 123,100 employees. Of these 20 firms, six were either health care providers or provided support services for health care.

**Property/Land Values**
For residential properties, data on median value and median gross rent is available from the U.S. Census Bureau for sample years 1990 and 2000 (see **Table 14**). Since Broomfield County was not formally established until November 15, 2001, Broomfield County data was not

available for the 2000 census. The regional average includes all counties except Broomfield County. Between 1980 and 2006, residential home values in the Denver MSA increased at an average rate of $6,400 per year (Local Market Monitor 2007).

**Table 14**
**Median Residential Property Values and Median Gross Rents for the State, Counties, and Region**

| Year | Colorado | Counties | | | | | | Region Average |
|---|---|---|---|---|---|---|---|---|
| | | Adams | Arapahoe | Boulder | Denver | Douglas | Jefferson | |
| Median Value (Dollars) for Specified Owner-Occupied Housing Units | | | | | | | | |
| 1990 | $82,400 | $71,300 | $92,500 | $102,300 | $78,300 | $119,900 | $93,400 | $92,950 |
| 2000 | $166,600 | $149,800 | $171,700 | $241,900 | $165,800 | $236,000 | $187,900 | $192,183 |
| Median Gross Rent (Dollars) for Specified Renter-Occupied Housing Units | | | | | | | | |
| 1990 | $418 | $434 | $463 | $502 | $386 | $597 | $476 | $471 |
| 2000 | $671 | $705 | $735 | $825 | $631 | $1,053 | $760 | $785 |

*Source: U.S. Census Bureau 2000 Data Sets (Summary File 3 (SF3), Tables H63 and H76. U.S. Census Bureau 1990 Data Sets (Summary Tape File 3 (STF 3), Tables H043A and H061A.*

The regional average value for owner-occupied housing exceeded the state average by 13 percent in 1990 and by 15 percent in 2000. The regional average for gross rent exceeded the state average by 13 percent in 1990 and by 17 percent in 2000. Both of these indices of residential properties show that the Denver region has a higher demand for residential property compared to the state, which is reflective of the stronger regional economy relative to the state.

The region's commercial and industrial real estate markets have been strengthening in recent years (MetroDenver EDC 2007a). Vacancy rates have been decreasing and lease rates rising as the commercial real estate market has strengthened. During the January-March period, about 2.23 million square feet of new office space among 76 buildings was under construction compared to 1.33 million square feet in the prior quarter and 1.21 million square feet in the same quarter last year. About 30 percent of the total square footage underway will be added in the City and County of Denver. Douglas County projects account for almost one-quarter of the total square footage underway, followed by Arapahoe (22.8 percent) and Jefferson Counties (19.6 percent) (MetroDenver EDC 2007a).

Both office and industrial available space has been growing at an average annual rate of 0.8 percent (3.6 percent increase over the four-year period between 2003 and 2007). Lease rates for office space only recently increased over 2003 rates; lease rates for industrial space have yet to recover their 2003 levels. Vacancy rates for commercial office space are above the national average of 10.4 percent; vacancy rates for industrial space are below the national average of 8.1 percent.

### *d. Jobs/Housing Balance*

The jobs/housing balance is the relationship between the number of persons employed in an area versus the potential housing opportunities in that area. In theory, a balanced community would have 1.0 to 1.5 employees for every housing unit. A ratio substantially over this range indicates an employment center where there are more jobs than housing available. Workers would need to travel to these employment centers from their homes within the region. Conversely, a ratio less than this range indicates a primarily residential node where there is more housing than jobs available. Factors such as major employment centers,

commercial/retail nodes, housing density, and boundaries of analysis areas can greatly influence this balance. Another limitation on the usefulness of the jobs/housing balance metric is the limiting data on transportation behavior across an entire region. Unless you have a full transportation behavior inventory, there is no real way to assert that in a metro region there's no cross-hauling of workers and residents across neighborhoods.

The employment and housing unit figures were based on 2006 estimates from DRCOG (DRCOG 2006a; DRCOG 2006b). Employment includes wage and salary employment as well as self employment and contract employment. Data for each of the 9 counties and the region are presented in **Table 15**.

**Table 15**
**2006 Jobs/Housing Ratios**

| Geographic Area | Employment* | Housing Units | Jobs/Housing Ratio |
|---|---|---|---|
| Adams | 180,224 | 159,003 | 1.1 |
| Arapahoe | 325,285 | 223,798 | 1.5 |
| Boulder | 180,010 | 124,403 | 1.4 |
| Broomfield | 35,723 | 18,688 | 1.9 |
| Denver | 497,844 | 271,562 | 1.8 |
| Douglas | 104,439 | 96,476 | 1.1 |
| Jefferson | 255,132 | 225,018 | 1.1 |
| Regional Average | 176,405 | 125,304 | 1.4 |

*Source: DRCOG 2006a; DRCOG 2006b.*

**Wage and Salary, Contract Employment, and Self Employment*

Broomfield and Denver counties have jobs/housing ratios greater than 1.5, meaning that there are slightly more jobs than housing available. Adams, Arapahoe, Boulder, Douglas, and Jefferson counties have jobs/housing ratios that fall between 1.0 and 1.5, representing communities that have a balance between jobs and housing. The regional jobs/housing ratio is 1.4.

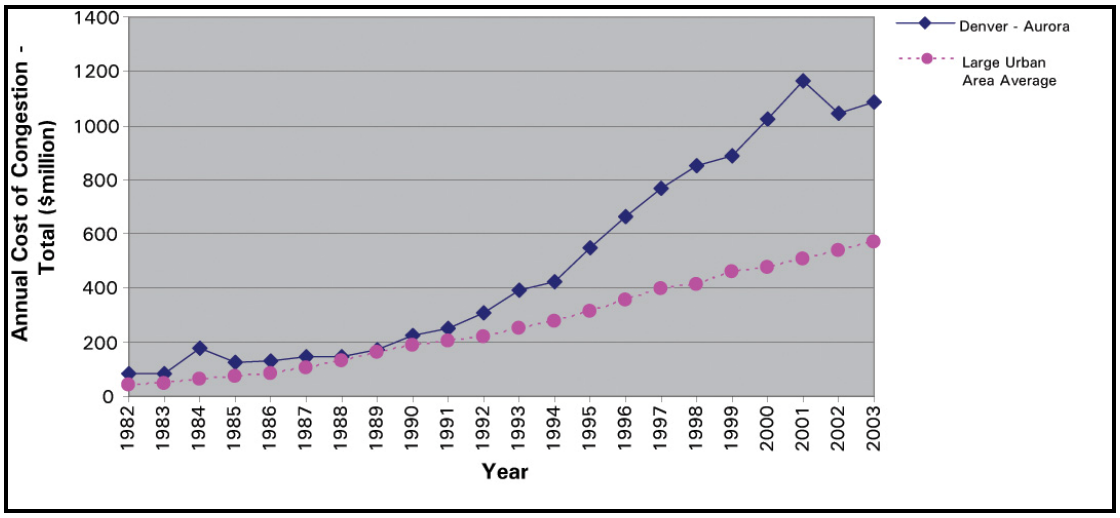
### *e. The Cost of Congestion*

The Texas Transportation Institute has studied congestion trends since 1982. The study results are published annually in the Urban Mobility Report, which is cited for its catalog of congestion delays in the nation's busiest cities, congestion costs, and other related topics (Schrank and Lomax 2005). Congestion in Denver-Aurora has historically been worse over the past 15 years than other large urban areas (Schrank and Lomax 2005). During this time, the costs associated with congestion have also been notably higher to travelers and employers in Denver-Aurora than other large urban areas.

In 2003, the total annual person-hours of delay caused by congestion in the Denver-Aurora MSA were 64,506,000 hours. This was almost double the average Annual Delay—Person Hours for other large urban areas (33,647,000 hours). Between 1982 and 2003, Denver-Aurora's Annual Delay—Person Hours grew from 8,883,000 hours to 64,506,000 hours (approximately an 8-fold (800 percent) increase). During this same time, the Annual Delay—Person Hours of other large urban areas grew from 4,447,000 hours to 33,647,000 hours (approximately a 7.5-fold (750 percent) increase).

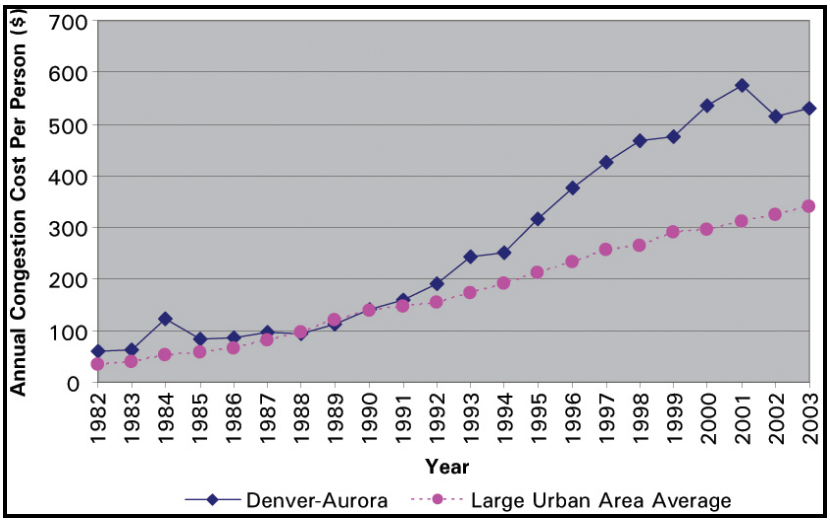
In 2003, Denver-Aurora's total annual congestion cost was $1,087,000,000. The same year, the total annual congestion cost for other large urban areas was $572,000,000. Between 1982 and 2003, Denver-Aurora's total annual congestion cost increased from $82,000,000 to $1,087,000,000, a 13-fold (1,325 percent) increase. During this same time, the total annual congestion cost for other large urban areas increased from $41,000,000 to $527,000,000, also a 13-fold (1,285 percent) increase. Trends in Total Annual Congestion Cost for Denver-Aurora and other large urban areas are illustrated in **Figure 18**.

**Figure 18**
**Total Annual Congestion Cost**




In 2003, the annual congestion cost per person in Denver-Aurora was $530. The same year the annual congestion cost per person for other large urban areas was $339. Between 1982 and 2003, Denver-Aurora's annual congestion cost per person increased from $61 to $530, an almost 9-fold (869 percent) increase, while for other large urban areas the annual congestion cost per person increased from $34 to $339, a 10-fold (997 percent) increase. Trends in Annual Congestion Cost per Person for Denver-Aurora and other large urban areas are illustrated in **Figure 19.**

**Figure 19**
**Annual Congestion Cost per Person**




Congestion costs have impacted individual travelers and businesses in the region (particularly those relying on just-in-time processes) by eroding personal income and business profits.

## 4. Future Economic Objectives for the Region

The City of Denver updated their Comprehensive Plan in 2000; the economic component of the Comprehensive Plan update focused on creating a sustainable economy that provides opportunities for all. The challenge will be to sustain and spread the current strong economy with strategic planning and action and with aggressive economic development. The *2000 Comprehensive Plan* has identified six economic objectives to make Denver's economy sustainable:

- **Workforce Development and Support**—Ensure a skilled workforce. Economic development policies and initiatives should stress workforce needs for advancement, education and training, child care, a full range of affordable housing options, and transportation.
- **Business Environment**—Stimulate the growth of business and the creation of good jobs with a business-friendly environment.
- **Expand Economic Opportunity**—Continue to expand economic opportunity and the city's economic base with focused efforts to retain and expand existing businesses and to attract new businesses, especially in target industries.
- **Business Centers**—Develop Denver's business centers to be competitive regionally, nationally and internationally, with the highest concentration of commerce in Downtown.
- **Neighborhood Economic Development**—Support the creation and growth of neighborhood businesses that enhance the vitality and quality of life in their communities.

- **Technology**—Build and maintain a leading-edge technology infrastructure within Denver.

MetroDenver Economic Development Corporation prepared a study to support the economic objective of expanding economic opportunity by focusing on industrial clusters (MetroDenver EDC 2006a). The concept of industry clusters, defined as geographic concentrations of interconnected companies and institutions in a particular field, would be used to focus economic growth within the Denver region.

The Denver region is currently focused on retaining and growing nine key industry clusters in an effort to diversify the economic base, increase the average wage, and utilize natural and labor resources more fully:

- Aerospace
- Aviation
- Beverage Production
- Bioscience
- Broadcasting and Telecommunications
- Energy
- Financial Services
- Information Technology—Hardware
- Information Technology—Software

## 5. Future without Fastracks

### *a. Employment*

The labor force in the Denver area is forecast to increase by approximately 1 percent annually till the year 2030. **Figure 20** and **Figure 21** show this trend for the counties in the Denver area and the Denver Area in general. Without FasTracks the region would not receive the economic stimulus associated with infrastructure investment during both the construction and operation of FasTracks. Labor force projections are from the State Demography Office, Department of Local Affairs.

### *b. Employment Areas*

Employment in the region is projected to grow at an annual rate of 1 percent between 2005 and 2030. Existing employment areas would likely see corresponding growth. However, reduced mobility and increased congestion could restrain some of the projected growth, and/or shrink the draw area from which employment areas could attract employees (due to increased commute time).

**Figure 20**
**Forecast of Persons in Labor Force by County**

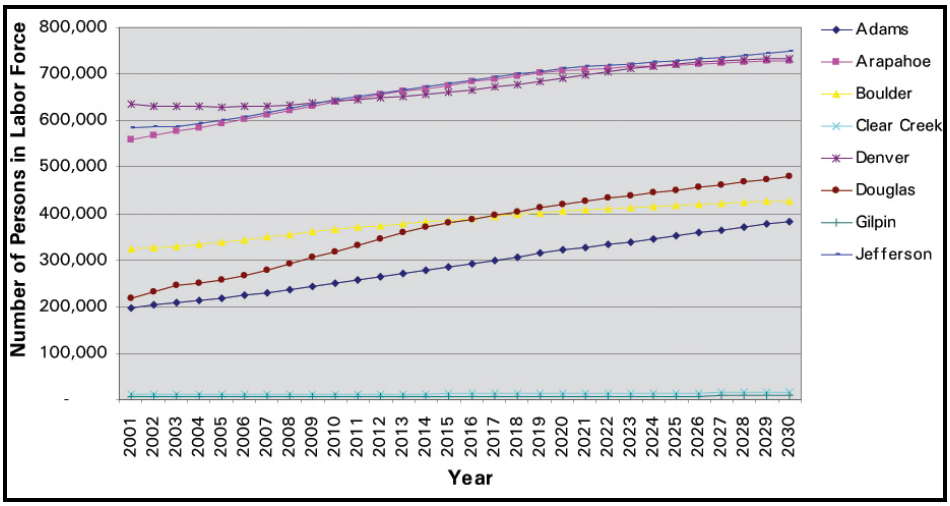
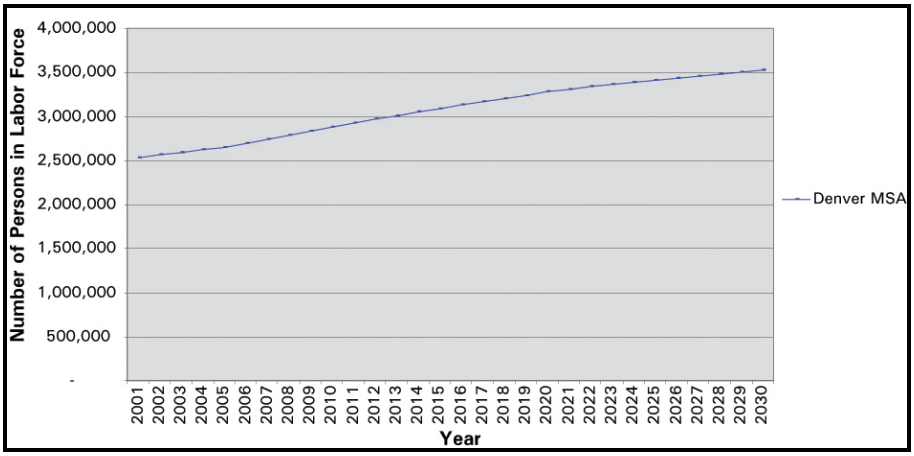



**Figure 21**
**Forecast of Persons in Labor Force for the Denver Area**




## *c. Economic Base and Property/Land Values*

**Economic Base**

The future without FasTracks is expected to negatively affect the future livability and quality of life improvements compared to the Future with FasTracks and as a result will negatively affect the region's ability to attract and retain both employees and businesses. Negative livability issues related to congestion will also negatively affect the desirability of the Denver region to attract new workers as they will be competing with all users of the surface roadway network to reach their destinations. The economic objectives related to affordable transportation options and neighborhood economic development will not be realized.

**Property/Land Values**

There is very limited projection data on property values given the multitude of variables that can impact property values. According to DRCOG, single-family home values increased by 6.3 percent between 2003 and 2006 (DRCOG 2007). Given the softening in the housing market nationally and relatively flat interest rates, it could be expected that in the short term, home values would either follow a similar trend as 2003-2006, or begin to flatten out. Home values in Denver will likely not experience the double-digit gains like they have in some markets (Las Vegas, Phoenix, Salt Lake City) in recent years (DRCOG 2007). Using the historic (1980 to 2006) average increase of $6,400 a year and the 2006 average residential home price for the Denver-Auruora MSA of $244,000, by the year 2030 the average residential home price would be approximately $398,000, an increase of 63 percent.

### *d. Jobs/Housing Balance*

DRCOG forecasts employment and housing data for year 2030. This data is used to estimate jobs/housing ratios in the region (see **Table 16**).

**Table 16**
**Year 2030 Jobs/Housing Ratios**

| Geographic Area | Employment* | Households | Jobs/Housing Ratio |
|---|---|---|---|
| Adams | 385,279 | 246,204 | 1.6 |
| Arapahoe | 442,901 | 328,094 | 1.3 |
| Boulder | 235,650 | 154,145 | 1.5 |
| Broomfield | 62,432 | 31,201 | 2.0 |
| Denver | 703,072 | 328,005 | 2.1 |
| Douglas | 144,666 | 185,882 | 0.8 |
| Jefferson | 375,736 | 282,128 | 1.3 |
| Regional Average | 335,677 | 222,237 | 1.5 |

*Source: DRCOG 2006c; DRCOG 2006d.*

In 2030 Arapahoe, Boulder, and Jefferson counties would still have jobs/housing ratios that fall within the range for a balanced community (a community that has a relative balance between jobs and housing). Adams, Broomfield, and Denver counties would have jobs/housing ratios that indicate more jobs than housing, while Douglas County would have a jobs/housing ratio that indicates more housing than jobs. Overall, however, the regional jobs/housing ratio would not change substantially. Job/housing ratios by corridor will be discussed in individual corridor documents.

### *e. Cost of Congestion*

In the future without FasTracks, it would be expected that, in general, traffic congestion and the cost of congestion would continue to be worse in the Denver-Aurora area than other large urban areas. While there is some indication that some progress has been made in narrowing the gap between Denver-Aurora and other large urban areas, the anticipated growth in the region may prevent Denver-Aurora from notably improving its traffic congestion and cost of congestion in comparison to other areas. Using the historic (1982 to 2003) average annual increase in annual delay for the Denver-Aurora area (2,648,714 hours per year) and the year 2003 total person-hours of delay caused by congestion (64,506,000 hours), by the year 2030 the total person-hours of congestion could more than double to 136,021,000 hours without FasTracks. Using the same methodology, the 2003 annual cost of congestion of $1,087,000,000 could more than

double to $2,379,000,000 in the year 2030 and the 2003 annual congestion cost per person of $530 could also more than double to $1,132 per person in the year 2030.

## 6. Future with FasTracks

FasTracks would somewhat improve the region's traffic conditions and reduce congestion, thereby slightly decreasing the cost of congestion for individuals and businesses (see Air Quality and Energy sections for more detailed information). The growth rates of measures such as number of rush hours and total annual congestion cost would likely slow, and it would be expected that the trendlines would begin to level-off. FasTracks would likely help Denver-Aurora to narrow the gap between itself and other large urban areas for the cost of congestion measures.

The Future with FasTracks is expected to increase the overall future livability of the Denver region relative to other major employment regions across the United States thereby increasing its relative attractiveness for businesses and employees wishing to relocate. The perception of Denver as an attractive place to relocate will result in a steady influx of businesses and employees that will support the cluster industries identified for retention and growth.

### *a. Employment*

**Direct and Indirect Employment during Construction**

Employment and economic activity associated with construction of the FasTracks system would result in additional (gross) employment and activity throughout all economic sectors within the Denver region. This gross employment and economic activity are derived from the multiplication effects on the capital expenditures for the project.

Examples of capital expenditures include the direct hiring of temporary construction workers, the purchase of construction materials and equipment, and the expenditure of capital funds to acquire new rights-of-way. For purposes of assessing the economic impacts on output, earnings, and employment, the focus is placed on the project capital costs (construction and right-of-way acquisition) of the sum of all components of the FasTracks system as an accurate measure of the capital investment that would likely occur for the project. The project costs associated with trains and buses ("rolling stock") are not included in this analysis as they are assumed to be constructed outside of the Denver region.

For every dollar spent on construction capital cost, over 2 dollars of additional economic activity would be generated in the Denver region. This additional economic activity would occur across all economic and labor sectors. For every dollar spent on capital costs translates directly into $0.72 in new wages and salary earnings for the jobs generated outside of the construction field.

For the FasTracks system, new demand for construction (including design) and right-of-way services would generate gross direct impacts equal to the capital cost of $4,312 million of construction dollars ($3,800 million for construction and $512 million for right-of-way). The gross multiplied impact on output would total approximately $9,477 million for all industries not directly involved with construction of the FasTracks system. Of this amount, $2,844 million would be paid to workers as wage and salary earnings for the jobs generated beyond those directly involved with construction of the FasTracks system.

The estimated average number of jobs directly related to construction of the FasTracks system would be 2,171 jobs per year, representing about $217 million per year in wages and benefits

per year, assuming a seven-year construction duration and an hourly rate of $48 for wages and benefits. The 2,171 direct employment jobs per year would generate approximately 5,000 additional indirect jobs per year in the Denver region for all industries not directly involved with construction of the FasTracks system.

**FasTracks Direct and Indirect Employment during Operation**
Existing employment data for the light rail segment of the Denver Regional Transportation District (RTD) was collected from the 2005 National Transit Database (Federal Transit Administration 2005). In 2005 RTD had full-time 286.8 employees working for the light rail segment of the entire RTD transit system. These employees included operations, maintenance, and general administration. In 2005, RTD had 32.1 miles of track used by their light rail system. This equates to 8.9 full-time employees per mile of light rail track. For all transit systems reporting to the National Transit Database, 15,931 full-time employees were working to support 1,298 light rail track miles for a nationwide average of 12.3 employees per mile of light rail track.

RTD does not currently operate commuter rail lines but will with the full implementation of FasTracks. For all transit systems reporting to the National Transit Database, 46,430 full-time employees were working to support 4,922.6 commuter rail track miles for a nationwide average of 9.4 employees per mile of commuter rail track.

FasTracks would create long-term operations, maintenance, and general administration jobs. Based upon the current employment figures for RTD light rail operations, it is estimated that FasTracks would create employment for approximately 1,100 workers. This is based upon an increase of 27.4 track miles of light rail and 90.9 new track miles of commuter rail to the RTD system.

The long-term employment benefits will also have a multiplier effect on the regional economy, resulting in additional expenditures and a more robust economy. For every 1,000 workers hired for the operation of FasTracks, 1,533 jobs in all industries not involved with transit operations will be generated (BEA 2004).

### *b. Employment Areas*
Urban development will occur consistent with local government comprehensive plans. Some of these plans have addressed FasTracks and identified how a local area would encourage transit oriented development.

FasTracks would improve transit service to and from employment areas, thereby widening the draw area for employers and providing them with a more diverse pool of candidates. The project may also have some impacts on commute patterns to and from employment areas, although the result of these changes is unknown. FasTracks may allow some workers that rely heavily or entirely on mass transit to reach employment centers that they would otherwise not be able to reach lacking vehicle ownership. Moreover, FasTracks could make regional employment areas more attractive for businesses considering relocating, and for potential job-seekers considering moving to the region.

### *c. Economic Base and Property/Land Values*

**Economic Base**
The economic base of the Denver region is not expected to change much within this 25-year period; however, the distribution between sectors will change. As the population increases in the Denver region, the portion of the economy generated by local government activity is expected to grow relative to state and federal government economic activity. Telecommunications, technology, and tourism are expected to continue to be large drivers of Denver's economy. The economic objectives related to affordable transportation options and neighborhood economic development could be realized through transit-oriented development by implementing FasTracks.

**Property/Land Values**
Many studies have been done on impacts of transit on property values (residential and commercial) [Still 2003 (revised; Smith and Gihring 2006 )]57. Many of these studies are specific to rail or bus rapid transit. Overall, the effect is that mass transit has a positive impact on property values. Studies conducted on other cities are presented to qualitatively describe what the impacts to property values could be in Denver once FasTracks is implemented. There is no way to quantify the specific cumulative impacts of the wide array of development, infrastructure, and transportation projects in the region on property values. However, it could be assumed that these projects would improve property values by making the region a more appealing place to live and work. Likewise, there is no way to quantify what the effect of FasTracks would be, in terms of property values, because of the wide array of factors that could affect property/land values. Appendix A shows results from a number of studies that have looked at the impact of mass transit on property values. This information provides a general idea of the impact that FasTracks could have on property values.

### *d. Jobs/Housing Balance*
The main anticipated impact of FasTracks on the jobs/housing balance would be a shift in the jobs/housing ratio for some areas. For example, a community may designate in their comprehensive plan and through zoning changes that they desire more commercial development (i.e. job centers) near stations. This could result in a shift in the jobs/housing balance toward more jobs than housing in these areas. If a community's jobs/housing balance already leans toward jobs, than a decision to promote commercial development at stations could amplify the jobs/housing ratio toward jobs. On the other hand, a community that has emphasized higher-density housing developments near stations would likely see their jobs/housing ratios shift toward housing. Communities that plan for and actively encourage mixed uses near stations would likely be working toward a more balanced jobs/housing ratio.

### *e. Cost of Congestion*
In the future with FasTracks, it would be expected that, in general, traffic congestion and the cost of congestion could see some improvement, if FasTracks converts enough single-occupancy drivers to transit riders. However, the extent of the potential improvement is unknown, and dependent on a variety of factors including, but not limited to, willingness to ride transit, fuel prices, and regional growth compared to transit capacity.

FasTracks is currently predicted to decrease annual vehicle miles traveled (VMT) in the Denver metropolitan area by 0.44 percent. This will be achieved by doubling the number of transit users during peak period, from 11 percent to 22 percent, along the major transportation

corridors (RTD 2004). The decrease in VMT, coupled with the decrease in travel time for users of FasTracks compared to single-occupancy vehicles and the increase in local bus service, could be expected to lower the rate of growth of the cost of congestion for the Denver-Aurora MSA. The cost of congestion for the Denver-Aurora MSA will still continue to rise but at a rate that more closely aligns with the national average for other large urban areas. Using the historic (1982 to 2003) average annual increase in annual delay for the national average for other large urban areas (1,390,476 hours per year) and the year 2003 total person-hours of delay caused by congestion (64,506,000 hours), by the year 2030 the total person-hours of congestion could increase to 102,050,000 hours with FasTracks. Using the same methodology, the 2003 annual cost of congestion of $1,087,000,000 could increase to $1,712,000,000 in the year 2030 and the 2003 annual congestion cost per person of $530 could also increase to $922 per person in the year 2030.

## 7. Potential Mitigation and Recommendations

### *a. Corridor Mitigation, to be Implemented by RTD*

Implement mitigation measures described in the individual studies for the separate FasTracks corridors. This could include measures such as providing adequate communication during construction to minimize effects to businesses.

### *b. Programmatic Mitigation, to be Implemented by RTD*

- Refine design at preliminary engineering to reduce right-of-way requirements, as appropriate, to minimize loss of property taxes.
- Compensate any person(s) whose real property is affected by the project according to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (Uniform Act).
- Consult with local governments, coordinating project design and planning with local plans and future updates to those plans.
- Continue marketing and encouraging the use of transit passes.

### *c. Recommendations, to be Implemented by Entities other than RTD*

- Encourage employers to make acquiring transit passes easier for their employees (responsibility of local agencies).
- Encourage employers to provide subsidized transit passes for their employees by providing tax credits or other incentives (responsibility of local agencies).
- Encourage employers to locate near employment centers served by transit (responsibility of local agencies).
- Work closely with land owners near stations and stops to encourage TOD opportunities (responsibility of local agencies).

# C. Water Quality

## 1. Introduction

There is a general correlation between the ecological health of the FasTracks corridors and water quality. FasTracks rail and bus lines, structures, and facilities will cross or be located near various major perennial and intermittent watercourses which provide productive aquatic and wildlife habitat and important riparian zones connecting protected open space. The importance of water quality and these natural corridors has become an increasingly critical issue as the area continues to urbanize and availability of valuable habitat diminishes.

**Methodology and Assumptions**

- Water quality evaluations were conducted through in-depth review of current information provided by various government agencies, Denver Regional Council of Governments (DRCOG) 2030 Clean Water Plan, Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Commission, and local county databases.
- Analyses of potential impacts to water quality were considered for the future with and without FasTracks. Focus of the analysis was to determine if either alternative would contribute to increased pollutants/degradation in water quality levels.
- Land use mapping and information provided by FasTracks projections were used to determine assumed acreage of new impervious surfaces.
- The CDPHE 303(d) impaired water segment list was reviewed for a baseline of existing problem areas and cross referenced with the land use section in determining future locations of increase in impervious surfaces near waterways. Only impaired stream segments that fall within the study area were considered.
- For either alternative, all future transportation oriented developments within the study area were assumed to follow at the minimum, current water quality guidelines during planning and construction phases and as not introducing increased or new pollutants to water systems based on these guidelines.

## 2. Historic Conditions

Before the city of Denver was established, the South Platte River and Cherry Creek were oases for people who traveled the semi-arid Great Plains, where the first residents of the area were able to drink water directly from the creeks and rivers.

After a gold discovery at the confluence of Cherry Creek and the South Platte River, the city of Denver was founded in 1858. This establishment led to the great Colorado gold rush that brought an influx of settlers into the plains, foothills, and mountain areas to start mining camps. These new residents built a network of dirt trails and railroads which quickly established the town as a central processing center for Colorado and neighboring states. In addition to being founded as the main supply town for Rocky Mountain mining camps, Denver also served as a hub for high plains agriculture which tapped into existing waterways and created an early system of irrigation lines and ditches for improved crop production.

Alterations to the landscape and encroachment into the existing waterways resulted in the initial degradation of water quality for the area and introduction of contaminants. Additionally, being in

a location next to the Rocky Mountains and outlying foothills, the study area has been exposed to rapidly changing, an often unpredictable weather systems that have created flash flood events in the area waterways resulting in bank erosion, scouring, increased sediment loading, and excessive accumulation of pollutants. Examples of several flood events and their effects within the last 50 years include::

- **May 8 and 9, 1957:** Over four inches of rainfall fell in a storm over eastern Colorado around Sand Creek. The floodwaters from this storm receded along Sand Creek within 12 hours but still produced a discharge of approximately 25,000 cubic feet per second (cfs) at Stapleton. Most of the damage from this event was due to erosion undercutting houses, damaging bridges, and eroding railway embankments.
- **July 23 and 24, 1965:** Heavy rain fell over Denver and Aurora and washed out earthen bridges over Sand Creek and caused flooding of roads, streets, and bridges.
- **May 5 and 6, 1973:** The South Platte Basin experienced a storm event that brought up to six inches of rain to the area causing major flooding during the following two weeks along Clear Creek, Sand Creek, and the South Platte River. Damages from this event resulted in approximately 120 million dollars and loss of human life.

Historically, water quality protection from storm runoff was not typically provided in new development projects, including highway, bridge, and street developments. As a result, during rain events and times of high water levels in waterways, pollutants and sediments that accumulated on impervious surfaces were flushed into the receiving stream causing a detrimental effect on stream water quality.

Results of past flood events helped spur the formation of development guidelines for transportation, commercial, and residential projects located within waterways and floodplains subject to flooding. These water quality guidelines helped shape planning processes during Denver's 1970s energy boom when a proliferation of suburban subdivisions, shopping malls and a second office core in the suburban Denver Tech Center was established. In 2000, the metro area reached a population of 2.1 million, three-fourths of whom live in the suburban counties. The current population is now approximately 2.6 million and with such a large population, water quality is a high concern requiring constant attention.

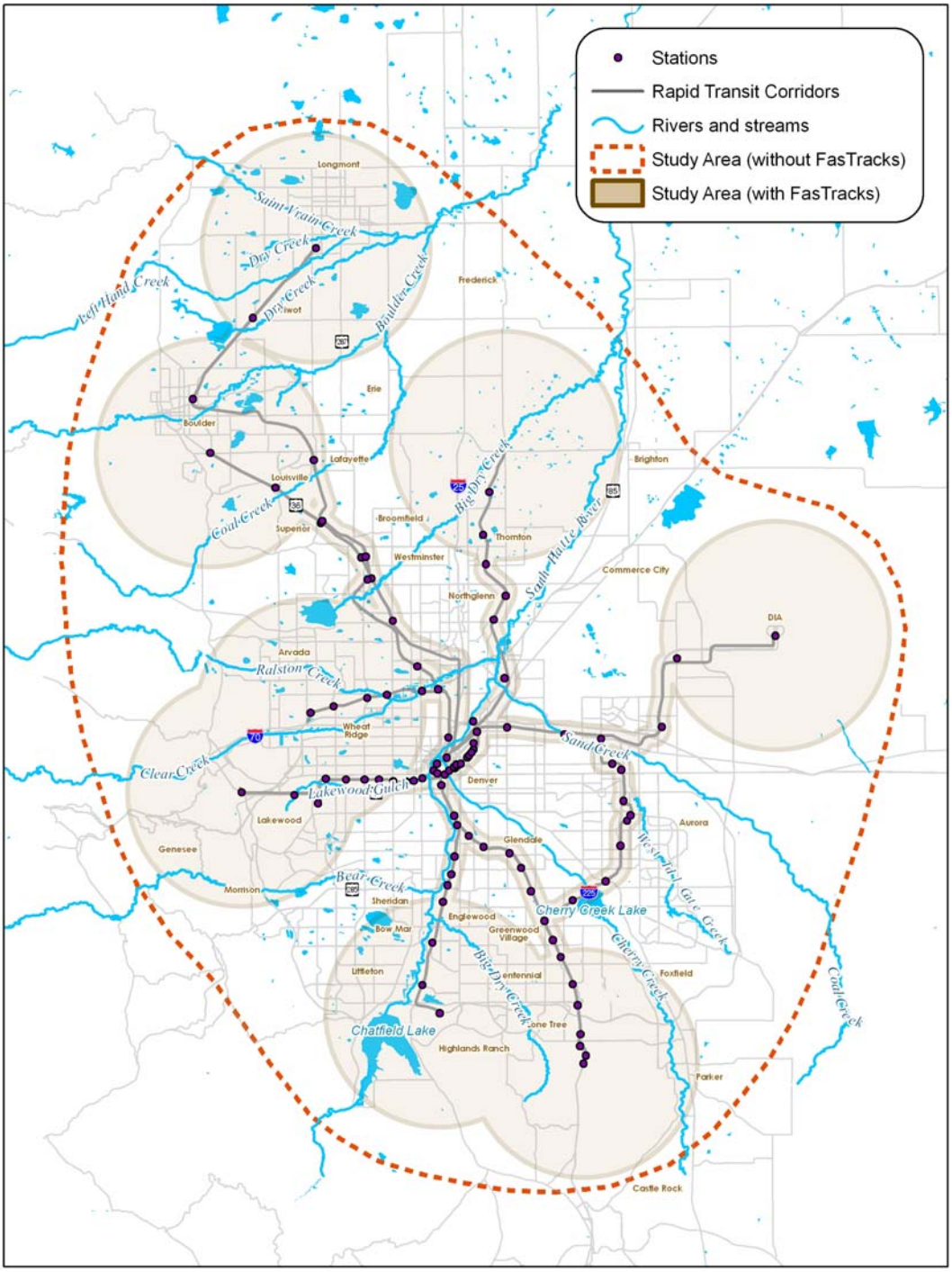
## 3. Current Issues and Challenges

Currently, water flows associated with watersheds in the study area occur within mixed-use lands that may include agricultural, urban, brownfields (e.g., redevelopment of contaminated sites), and open plains. Many of the streams in the metropolitan region are effluent and/or urban runoff dominated. Presently, water quality in the groundwater beneath urban areas has been degraded with high concentrations of volatile organic compounds (VOCs), while surface water within the mixed-use land areas has been degraded by VOCs, organochlorines, and in the past, polychlorinated biphenyls (PCBs). Compounds such as PCBs and chlordane were historically widely used substances, but have since been banned after being discovered in fish tissue. Other impacts to the basin and its waters from urban development have occurred from stream channel modification for flood control and bank stabilization, which have altered the available habitat to biological communities and resulted in areas of riparian vegetation removal. Water quality in agricultural areas of the basin is the most degraded primarily from nitrate and salinity in the groundwater, and salinity and suspended sediment in surface water.

Several different water basins occur within the study area, with the largest being the Platte River basin at approximately 4,000 square miles containing various perennial waterways (see **Figure 22**). The basin reach receives flows from below Chatfield Reservoir in Jefferson County up through the Denver metropolitan area to the confluence of the South Platte River with the Cache la Poudre River in the east plains of Colorado. While water quality in the Platte River basin is generally good, urbanization, rapid growth, historical mining, and agriculture have created water quality concerns.

Urbanization, including the conversion of agricultural lands to new commercial and residential developments has increased impervious surfaces affecting the natural hydrology of area streams and contributing to the cumulative effects on water resources and quality. Development rapidly consumes and converts natural landscapes to impervious surfaces such as parking lots, roads, and rooftops, resulting in a loss of ground water infiltration. Water runs off these impervious surfaces, carrying pollutants directly into water bodies instead of filtering through the soil into underground aquifers. As growth and development increases, detrimental cumulative effects on the quality of local water resources and water supply can result from individually minor but collectively greater increases in impervious surface area over time. In addition, the construction of irrigation ditches and reservoirs greatly affects the natural hydrologic conditions of the streams and their groundwater levels. Much of the mineral extraction that has taken place in Colorado has occurred in the upper reaches of the South Platte River basin. The South Platte basin and Clear Creek, in particular, have been most affected.

**Figure 22**
**Rivers and Streams in the Study Area**



The basins draining through the study area are generally composed of agricultural, residential, and commercial developments. Typically, undeveloped land in the Denver Metropolitan Area can be expected to generate up to one cubic feet per second of stormwater per acre of drainage basin for a 100-year flood event. Developed land, such as that along the transit corridors, can generate stormwater runoff from two to five cubic foot per second per acre for a 100-year flood event. This increase in runoff creates flooding problems when not properly mitigated by stormwater detention facilities.

Areas of concern for water quality in the study area include water running off bridges, maintenance facilities, agricultural fields, and parking lots at transit stations which can contain metals, salts, oils, grease, herbicides, pesticides, and bacteria.

Federal water quality requirements were instituted with the passage of the Federal Water Pollution Control Act (FWPCA) Amendments of 1972. Title IV, Permits and Licenses, of the FWPCA created the system for permitting wastewater discharges known as the National Pollutant Discharge Elimination System (NPDES) permit program, which limits the amount of pollutants that may be discharged from a point source (such as a pipe). These limits are set at levels protective of both the aquatic life in the waters that receive the discharge and human health. In 1977, legal challenges forced the reorganization of the FWPCA into the Clean Water Act (CWA).

The CWA requires states to publish an updated list of water bodies that are not meeting their beneficial uses because of excess pollutants; these pollutants can be naturally occurring or be a result of human activity. The list, known as the Section 303(d) list, is based on violations of water quality standards and is organized by watersheds, which are further divided into stream segments.

Regulation Number 93, Impaired Waters, satisfies the Federal requirements of the Section 303 (d) reporting and CDPHE's Water Quality Control Division (WQCD) assigns the Total Maximum Daily Loads (TMDLs) to these impaired waters, which accelerates their cleanup.
Based on Regulation Number 93, the WQCD has identified various stream segments within the study area as impaired. The WQCD further defines pollutants that are the main cause for impairment and describes the portion of the segment for which the impairment applies, and assigns clean-up priority to each segment. **Table 17** summarizes these impaired waters.

**Table 17**
**Summary of 303(d) Impaired Water Segments in the Study Area**

| Water Body ID | Segment Description | Portion | Impairment | Priority |
|---|---|---|---|---|
| COSPBO07b | Coal Creek, Highway 36 to Boulder Creek | All | E. Coli | High |
| COSPBO10 | Boulder Creek, Coal Creek, to St. Vrain River | All | E. Coli | High |
| COSPCL14b | Clear Creek, Denver West Conduit #16 to Youngfield St. | All | Aquatic life use, organic sediment | Low |
| COSPCL15 | Clear Creek, Youngfield St. to S. Platte River | All | E. Coli, Aquatic life use, organic sediment | High/Low |
| COSPCL18a | Ralston Creek and Tributaries | Ralston Creek | E. Coli | High |

**Table 17**
**Summary of 303(d) Impaired Water Segments in the Study Area**

| Water Body ID | Segment Description | Portion | Impairment | Priority |
|---|---|---|---|---|
| | Below Arvada Reservoir | | | |
| COSPSV04a | Left Hand Creek, source to Hwy 36 | pH, Cu, Zn (Hwy 72 to James Creek); Cu below James Creek | pH, Cu, Zn | Medium |
| COSPSV06 | Tributaries to St. Vrain River | All | Se, E. Coli | Low/High |
| COSPUS14 | S. Platte River, Bowles Ave. to Burlington Ditch | All | E. Coli | High |
| COSPUS16a | Sand Creek | All | Se, E. Coli | Low/High |
| COSPUS16c | Tributaries to S. Platte River, Chatfield Reservoir to Big Dry Creek except specific listings | East Toll Gate Creek, West Toll Gate Creek, Toll Gate Creek | Se | Low |

*Source: Regulation Number 93, Section 303 (d) list Water-Quality-Limited Segments Requiring TMDLs, April 30, 2006.*

## 4. Future without FasTracks

Because development is occurring at such a rapid rate within the study area, it can be expected that growth will occur regardless of FasTracks construction. The difference between the future without FasTracks and the future with FasTracks would be in the density, variety, and timing of developments throughout the area. A future situation without FasTracks may carry a higher probability of sporadic development, urban sprawl, and conversion of undeveloped land with increases in direct and indirect impacts to water quality.

Most impacts would result from the increase of impervious surfaces in the study area caused by road widening and further residential and industrial development. The greater area of impervious surfaces would be expected to increase roadway runoff, surface flows in adjacent streams, erosion, and the creation of channels in wetlands that were previously free of channelization. Additional sedimentation and erosion would be expected during and after construction of other projects until bare fill and cut slopes could be successfully revegetated.

New flows may contain pollutants associated with roadway runoff. Additionally, traffic and maintenance requirements are expected to increase with the growth and expansion of urban sprawl. Larger volumes of traffic and road maintenance activities could further degrade water quality with increases of volatile organic compound runoff which is generally associated with petroleum products and may include Methyl tert-butyl ether and benzene. Winter maintenance practices, such as snow plowing, sanding, deicing, and runoff can move sand, salt, and debris into adjacent water bodies, altering the natural biochemical makeup.

The parameters listed in **Table 17**, establish the baseline water quality for beneficial uses in the stream segments located in the study area. Impacts to water quality without the construction of FasTracks were based on projected population growth and land use maps. There is a general correlation between the amount of new pavement and reduction in water quality due to increased runoff, however, with new guidelines under the CWA water quality is not expected to decrease beyond its current state, and could potentially increase with adherence to improved water quality guidelines.

Water quality trends in the Denver metro area show that most pollutant discharges and flood prevention controls instituted as a result of the CWA have been successful in reducing pollutant levels. However, water quality levels in the Denver area remain an ever present concern and will require concentrated attention on reduction and prevention processes to aid in the maintenance and continued sustainability.

Federal and state regulations currently require stormwater detention and treatment for most transportation improvements in the attempt to reduce degradation of water quality. This is important to future water quality and flood control as impervious surfaces in the study area are predicted to increase. Inclusion of water quality controls that are not required may result in improved water quality over the existing conditions. Likewise, new bridges would be designed to match the existing bridge or culvert span across the floodplain.

While the area is expected to grow, the levels of pollutants and water degrading chemicals are not expected to increase proportionately due to implementation of stricter regulatory controls.

## 5. Future with FasTracks

The installation of FasTracks new corridors, rail extensions, and upgrades will primarily occur in areas containing existing or previously used railways which will have minimal effects on existing waterways. Increases of impervious surface are anticipated with the installation of thirty-one new park-n-Rides, providing more than 21,000 new parking spaces (approximately 280 acres), and from new transit stations and maintenance facilities which could add approximately 100+ acres of new impervious surface. With these new installations (almost 400 acres), the FasTracks project will be committed to maintaining historic drainage patterns and to improving water quality through implementing mitigation measures and proper permitting conditions.

Transit oriented development around existing and proposed FasTracks stations is anticipated to result in planned population growth which is expected to contribute to denser land development centered within one-half mile of each station. This form of future concentrated land use will contribute to increased commuter-oriented ridership and a reduction in sporadic urban sprawl. The greatest effect of planned population growth on water quality would be in the increase of impervious surfaces that trap pollutants and increase runoff to receiving waterways.

The parameters listed in **Table 17**, establish the baseline water quality for beneficial uses in the stream segments located in the study area. Impacts to water quality with the construction of FasTracks were based on projected population growth and preliminary design layouts. There is a general correlation between new pavement and reduction in water quality due to increased runoff, however, with new guidelines under the CWA and the projects potential to curtail urban sprawl, water quality is not expected to decrease beyond its current state, and could potentially increase with the development of FasTracks.

Based on past and present impacts, implementation of the proposed actions for FasTracks are anticipated to have minor impacts on water quality with few long-term effects. The majority of impacts are anticipated in the form of increases of impervious surfaces and minor alterations to areas of existing waterway to improve flood protection, which may result in loss of riparian vegetation. Long-term impacts to water quality could result from increased runoff of roadway contaminants (non-point source) resulting from an increase in pavement throughout the corridor.

Surface water quality impacts include increased impurities in stormwater runoff from impervious surfaces and maintenance activities. Surface water quality could be affected and degraded by contaminated parking lot runoff which contains suspended solids and organic and inorganic compounds. The FasTracks project will help offset these impacts with the implementation of avoidance and minimization measures, mitigation practices, and use of Best Management Practices (BMPs).

Groundwater beneath the study area has been impacted by prior use of properties and development activities within and surrounding the study area. Implementation of FasTracks is not anticipated to introduce any pollutants to groundwater and therefore is not anticipated to have any impacts on groundwater resources.

In addition to the adherence of strict water regulations and mitigation efforts, water quality in the study area is anticipated to degrade less than proportionately to new development due to better riparian area protection and improved public education regarding the use of toxic materials. It is also anticipated that redevelopment areas within the project corridor could be retrofitted with stormwater runoff controls, which, in many cases do not exist and could result in small improvements to overall water quality.

## 6. Potential Mitigation and Recommendations

In general, RTD will be responsible for ensuring that the agency and its contractors follow and implement local jurisdiction water quality requirements for impacts from RTD-owned facilities and right-of-way. Local jurisdictions are responsible for following and implementing water quality requirements for development impacts adjacent to the RTD system.

### *a. Corridor Mitigation, to be Implemented by RTD*

Each corridor will develop specific water quality mitigation as appropriate depending on potential impacts. For corridors with potential water quality impacts, at a minimum local jurisdiction requirements for BMPs for stormwater projection and erosion control should be followed. In addition, some or all of the programmatic mitigation below should be considered.

### *b. Programmatic Mitigation, to be Implemented by RTD*

RTD has adopted a sustainability policy that includes objectives for environmental sustainability, one of which is to enhance water quality and lower water use. Accomplishment of this objective is recommended through developing and adopting best practices for sustainable design, construction, operations, and maintenance. Specifically, RTD encourages evaluating the incorporation of LEED™ practices and urban drainage and flood control district BMPs in transit centers, park-n-Rides, shelters, and corridor projects. Improving stormwater quantity and quality should be accomplished using locally accepted/encouraged BMPs for protection of water quality (for example use of pervious pavement and construction of wetlands and bioswales).

Every effort should be made to minimize both temporary and permanent impacts to water quality to ensure the proposed action would not affect water quality, including wildlife, fish, and vegetation that depend upon the water. Strict adherence to water quality protection strategies can contribute to mitigating the cumulative impact resulting from the FasTracks corridors by implementing some or all of the following measures as necessary and appropriate:

**Design**

- Stations, park-n-Rides, maintenance facilities, and other corridor facilities should follow BMPs for stormwater and erosion control ordinances of the local jurisdiction where the facilities are located. Local requirements will likely require the permanent BMPs to treat runoff from developed areas.
- Facilities proposed in the vicinity of floodplains should incorporate designs that maintain pre-construction floodplain conditions.
- Adhere to the limits of permitted permanent and temporary impacts established in the Section 404 permits for each corridor.
- Extend dry detention ponds at park-n-Ride stations where space permits.

**Construction**

- Avoid unnecessary disturbance of wetlands or other vegetation areas adjacent to streams and waterways when a practicable alternative exists.
- BMPs for stormwater protection and erosion control for RTD facilities should be provided as required by local and state permits.
- Mitigation of construction impacts on water quality should be accomplished by implementation of temporary or permanent BMPs that reduce, minimize, or eliminate runoff into nearby surface waters at all times.
- Permanent water quality BMPs should be constructed first where practical for use during the construction phase. Similarly, to control stormwater runoff from newly constructed pavement and impervious surfaces, permanent BMPs should be constructed first where practical.
- Installation of temporary BMPs should be used for construction when permanent BMPs are not required or not yet available during construction. This includes mitigating areas where destruction or modification of riparian and vegetation areas cannot be avoided. Seeding and re-establishment of native vegetation should be accomplished as soon as possible after disturbance.
- To ensure that water quality is maintained in streams when construction vehicles need to cross a waterway, temporary stream crossings should be designed and constructed. Construction of any specific crossing method should not cause a significant water level difference between upstream and downstream water surface elevations. Construction should also not disturb or create a barrier in the stream channel during fish migration and spawning periods. Additional 404 permitting may apply.
- Adhere to the limits of permitted permanent and temporary impacts established in the Section 404 permits for each corridor.

**Operation and Maintenance**

- Operational impacts would be best mitigated by incorporating runoff management into design plans for impervious surfaces and new bridges, and involving monitoring programs that will ensure minimization of impacts. For ongoing operation and maintenance, RTD adheres to its current stormwater management plan under its

Municipal Separate Storm Sewer System (MS4) program which complies with the provisions of the Colorado Water Quality Control Act (25-8-101 et seq., CRS, 1973 as amended) and the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.).

- Each area under a permitted MS4 should establish a Stormwater Management Program (SWMP) under either Phase I or Phase II of the NPDES stormwater regulations.

### *c. Recommendations, to be Implemented by Entities other than RTD*

RTD recommends that local agencies and jurisdictions continue to make protection and improvement of water quality a top priority. Local agencies and jurisdictions provide a central role in the review and approval of development in and around the corridors including at stations and park-n-rides. As zoning changes are adopted and transit-oriented developments approved, local jurisdictions are encouraged to require not only adherence to BMPs, but also innovative strategies to address water quality.

# D. Air Quality

## 1. Introduction

In the Denver area, the daily pollution concentration peak periods are generally just after morning and evening rush hours. The worst problems occur where slow-moving traffic congregates, such as in large parking lots or traffic jams. Pollutants can temporarily accumulate to harmful levels in calm weather. The problem of inversions is more severe in winter because cold weather makes motor vehicles run less efficiently, street sanding and wood burning emissions from space heating are increased. In addition, in winter, strong atmospheric temperature inversions often develop, trapping pollutants near ground levels. During the summer, ground level ozone levels increase along the industrialized Platte River Valley and are often trapped against the Front Range foothills, concentrated by diurnal up-valley winds.

**Methodology and Assumptions**

- Air quality analyses utilize the EPA established National Ambient Air Quality Standards (NAAQS) for each of six "criteria pollutants" to protect the public from the health hazards associated with air pollution. The six criteria pollutants are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter less than 10 microns and 2.5 microns in diameter (PM10, PM2.5), and sulfur dioxide. NAAQS for these criteria pollutants were established based on known human health effects and measurable, health-related threshold values.
- In accordance with the Clean Air Act (CAA), EPA requires all states to submit a State Implementation Plan (SIP) to address all areas that do not comply with the NAAQS. A State Implementation Plan contains the set of actions or control measures that the state plans to implement to meet NAAQS.
  - Non-attainment areas contain one or more pollutants levels that are in violation of NAAQS.
  - Attainment/maintenance areas are those areas where relevant pollutant levels have been reduced and maintained over a prolonged period of time at or below EPA-approved NAAQS levels.
- The entire FasTracks program is located within the Denver SIP attainment/maintenance area for carbon monoxide (CO), 1-hour ozone and for PM10.
- A portion of the Northwest Rail Corridor is located within the Longmont CO attainment/maintenance area.
- Newly standardized 8-hour ozone levels are an imminent concern for the Colorado Front Range area. It is likely the area will be designated as non-attainment in early 2008.
- Denver area pollution sources include point sources such as the four area fossil-fuel burning power plants, large refinery complex, and industrial development, and area and mobile sources such as agriculture, wood burning, road sanding, rail locomotion and motor vehicle exhaust.
  - The SIP for each pollutant for the area attempts to measure existing air quality and then models projected emissions contributions from the various pollution sources. The total estimated emissions burden is then provided to establish the acceptable

capacity for incremental pollution resulting from current and future projects in the SIP geographic area.

  - All major transportation, construction, industrial, and mining activities are incorporated in this emissions budget to meet the constraints of the SIP attainment/maintenance plan and the regional conformity analysis under the Transportation Conformity Rule.
  - Project-level air quality analyses from individual FasTracks Corridors are then required to meet the Transportation Conformity Rule.

- An additional topic of concern for the FasTracks corridors includes mobile air toxics associated with urbanized and high-density transportation areas. There are currently no approved, consistent standards for measurement of these toxics, however, research is ongoing to determine airborne toxicity levels and their specific health risks. Diesel is one of these air toxics.

## 2. Historic Conditions and Trends

The Denver metropolitan area has grown significantly over the past 50 years, increasing from 930,000 in 1960 to 2.6 million people today. It is anticipated that the population will reach 3.88 million in the year 2030. The surrounding landscape has shifted steadily from a rural agricultural base to a more suburban sprawl, reflecting the tremendous residential growth between 1970-1990 and 2000-2005. The resultant land use changes have fostered a commuter society of outlying suburbs and traffic corridors radiating into the downtown.

For many decades, Amtrak, Burlington Northern-Santa Fe and Union Pacific Railroads and their affiliates have transported people and freight across the Denver area via standard rail track. Denver Union Station has acted as a passenger rail hub during this time and freight rail maintenance and layover yards still exist within the Denver metropolitan area.

Heavy industry has historically been focused in the Platte River Valley, but with development of the Denver Tech Center and proliferation in recent years of outlying business centers such as the old Stapleton airport and Interlocken North, traffic volumes and hours of congestion on regional highways have increased the need for public transit and better travel links to the business hubs. Increased traffic, industrial development, electric power needs, and housing construction will continue to be the main drivers in air quality issues for the Denver metro area. Vehicle and engine emissions control measures implemented statewide and by local governments will effectively reduce many air pollutant levels 30 percent to 90 percent in the future, even though the pace of growth and land use changes, and therefore roadway traffic will continue to increase.

### *a. Carbon Monoxide*

Carbon monoxide levels have dropped dramatically in the Denver-metro area since the late-1960s. Years with 100 or more exceedances of the 8-hour standard were common before 1976. In 1966, there were 367 exceedances of the 8-hour standard and since 2000, there have been none. The number of exceedances for the 1-hour standard has declined from 21 episodes per year in 1973 to zero since 1990. The 1-hour yearly maximum levels have declined from more than twice the standard in the late-1960s to less than one half of the standard in 2000.

### *b. Ozone*

Ozone monitoring began in downtown Denver in 1972 and eight exceedances of the standard were recorded that year. In 2000, a new 8-hour ozone standard was established to provide better protections for children and other at-risk populations against a wide range of ozone induced health effects. Ozone concentrations recorded showed no consistent trend until concentrations spiked in 1998 and 2003, with 2003 concentrations exceeding NAAQS in much of the study area. Monitoring stations throughout the study area returned to levels below the 8-hour and 1-hour standard concentrations after the 2003 peak. These multiple ozone NAAQS exceedances have led EPA to consider the Front Range for ozone non-attainment since exceedances have been recorded in 2005, 2006, and 2007.

### *c. Nitrogen Dioxide*

Nitrogen dioxide and other nitrous oxides are considered ozone precursors or airborne compounds that will react with sunlight to convert to ozone. Higher pollution levels of nitrogen dioxide contribute to higher levels of ozone under typical summer conditions. No violation of the nitrogen dioxide standard has occurred since 1977.

### *d. Sulfur Dioxide*

The trend in ambient concentrations for both of the monitors operated in the Denver-metro area has been flat-to-declining for the past 10 years. This is due to the limited number of large, coal-burning industrial sources in the area and the burning of low-sulfur coal.

### *e. Particulate Matter*

Total suspended particulates were first monitored in Denver in 1960. Particulate monitoring expanded to more than 70 locations around the state by the early 1980s. The primary standards for total suspended particulates changed in 1987, with the promulgation of the $PM_{10}$ standards. The last exceedances at a Denver monitor was recorded in 1999. Historically, Denver has had few problems meeting either the $PM_{10}$ or $PM_{2.5}$ standards.

### *f. Lead*

Lead levels have shown a steady decline since 1980, to the point where now all monitors are regularly at or near the minimum detectable limits of analysis. This decline is the direct result of the use of unleaded gasoline and replacement of older cars with newer ones that do not require leaded gasoline. The reduction in atmospheric lead suggests what pollution control strategies can accomplish.

## 3. Current Issues and Challenges

### *a. Mobile Source Air Toxics*

Primary sources of mobile source air toxics are from on and off-road engine emissions. Scientific research has indicated that the health risks to people exposed to mobile source air toxics (MSATs) at sufficiently high concentrations or for lengthy durations include an increased risk of contracting cancer, damage to the immune system, and neurological, reproductive, and/or developmental problems. Six priority MSATs are acetaldehyde, acrolein, benzene, 1, 3 butadiene, diesel exhaust, and formaldehyde. The EPA is in the process of assessing the risks of various kinds of exposures to these pollutants.

In 1999 the EPA published a strategy to reduce MSATs and two years later, issued regulations for automobile and truck manufacturers to decrease these pollutants by target dates in 2007 and 2020. Under the 2001 regulation, by 1990 and 2020, highway emissions of acetaldehyde,

benzene, 1,3 butadiene, and formaldehyde will be reduced from 67 percent to 76 percent, and highway diesel particulate matter emissions will be reduced by 90 percent. These reductions are net emission reductions which will occur even after growth in traffic is taken into account.

When evaluating the future options for extending or constructing a new FasTracks corridor, the major mitigating factor in reducing MSAT emissions is the implementation of EPA's new motor vehicle emission control standards. Substantial decreases in MSAT emissions will be realized from a current base year (2001) through an estimated time of completion for a planned project and its design year. Accounting for anticipated increases in VMT and varying degrees of efficiency of gas vehicles, diesel locomotion, diesel motorized unit (DMU) and bus operations, total MSAT emissions are predicted to decline more than 65 percent from 2001 to 2030.

The MSATs from mobile sources, especially benzene, have dropped dramatically since 1995, and are expected to continue dropping. In addition, Tier 2 automobiles (automobiles with low sulfur fuel requirements) introduced in model year 2004 will continue to help reduce MSATs. Diesel exhaust emissions have been falling since the early 1990s with the passage of the CAA amendments. The CAA amendments provided for improvement in diesel fuel through reductions in sulfur and other diesel fuel improvements. In addition, the EPA has further reduced the sulfur level in diesel fuel, effective in 2006 and will reach uniform required sulfur levels of 15 ppm for all diesel operating vehicles including rail by 2014. The EPA also has called for dramatic reductions in NOX emissions, and PM from on-road and off-road diesel engines.

### *b. Visibility*

Visibility is unique among air pollution effects in that it involves human perception and judgment. Denver's "Brown Cloud" has vastly improved since the 1970s, however, it still persists and the potential for worsening visibility is a metro area concern. In 2000 visibility was rated good to fair quality only 40 percent of the time. By 2005, 54 percent of the time visibility was gauged good or fair quality. Monitoring performed in and near national parks and wilderness areas shows pollution-related visibility impairment occurring north of the FasTracks corridors in Rocky Mountain National Park. The type of impairment most often impacting Colorado's important scenic mountain views is known as regional haze and is closely related to smaller particulate matter, PM2.5. Continued growth and conversion of agricultural land to housing and commercial development will act to add dust and particulate pollution to the atmosphere causing visibility impairments in the future.

### *c. Greenhouse Gases*

Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, ozone and chlorofluorocarbons. Fossil fuel production and use in the Denver area are expected to increase greenhouse gases, in particular carbon dioxide emissions by 43 percent in 2015. Methane from landfills (28 percent) and wastewater treatment (42 percent) are also expected to rise as a direct response to population growth in the area. These and other pollutants such as carbon monoxide, particulate matter under 10 and 2.5 microns in size, volatile hydrocarbon compounds, and nitrogen dioxide increases are related to land use changes and resultant traffic volume increases that are offset, in part, by traffic reductions resulting from the proposed FasTracks projects.

In 1990, 85 percent of all CO2 emissions in Colorado were generated by the utility and transportation sectors. Over 58 million tons of CO2 emissions are predicted statewide in 2015

from energy consumption by these sectors; transportation estimated at 35 million tons. The anticipated traffic reductions due to FasTracks ridership will slightly lower future CO2 emissions.

### *d. Nitrogen Deposition*

Nitrogen deposition is a concern in the Front Range mountains where pre-industrial era levels of nitrogen in the soil were 0.2 kilograms of nitrogen per hectare per year (kg/ha/yr). Today's levels have increased more than 15 times to 3.1 kg/ha/yr. It is estimated that the point at which damage from nitrogen saturation starts to occur at these protected high alpine sites such as Rocky Mountain National Park is 1.5 kg/ha/yr. Environmental stress due to this high accumulating nitrogen content kills sensitive tundra plant species, damages fir and spruce trees, changes water chemistry, and contributes to eutrophication of mountain ponds and lakes. Front Range area ammonia emissions were estimated at 3,264 to 4,045 tons per year from mobile sources in 2002 depending on the methodology used to calculate the emissions mass. As much as 8 to 10 percent of this excess nitrogen is generated by transportation related emission sources. By converting more vehicle traffic to transit ridership, nitrogen emissions, particularly NOX and ammonia, can help to reverse nitrogen deposition effects by contributing to overall nitrogen level reductions below the critical 1.5 kg/ha/yr goal.

Research currently evaluating nitrogen and ammonia emissions levels along the Front Range have concluded that a 23 percent reduction in NOX is anticipated by 2012. This results from a predicted 50 percent reduction from mobile emissions sources, expected flat stationary emissions, decreased off-road, and increased area source emissions. With implementation of additional NOX reduction strategies including the Best Available Retrofit Technology (BART) program, NOX reductions are anticipated to reach 30 percent by 2018.

## 4. Future without FasTracks

Air quality trends from the 1960s when ambient air monitoring began in the Denver metro area, to today, show that most pollution emissions controls and programs instituted as a result of the Clean Air Act and its amendments have been successful in reducing criteria pollutant levels. Ozone levels in the Denver area remain a concern and will require rigorous adherence to reduction programs and precursor emissions controls to prevent future air quality deterioration.

Future mobile source pollutant emissions of CO, NOX, PM, sulfur dioxide, lead, and MSATs are expected to continue to decline as a result of new low sulfur fuel requirements, stricter retrofit and engine exhaust emission controls, and engine efficiency improvements.

**Automobile Emissions**

The planned transportation improvements over the next 20 years will increase auto speeds by only 0.8 miles while VMT is predicted to increase 163.3 percent by 2030.

## 5. Future with FasTracks

### *a. FasTracks Pollutant Levels*

Results for FasTracks corridors air quality studies to date indicate that the incremental effect of FasTracks transit facilities and service would not result in any additional air quality impacts and will act to reduce the growth of single occupancy vehicle use by 158.38 million vehicle miles traveled per year, lowering VMT while generating lower overall pollutant emissions levels. However, new transit vehicle emissions partially offset some of these emissions reductions. Diesel bus VMT will increase 21.73 percent or 9.18 million vehicle miles traveled per year and

rail options (including diesel commuter, light- and heavy-duty rail) will increase 5.8 million vehicle miles per year. These changes in auto and bus are anticipated to reduce CO emissions by approximately five tons/day. Other pollutants (particulates, VOCs and NOX) would have no measurable change.

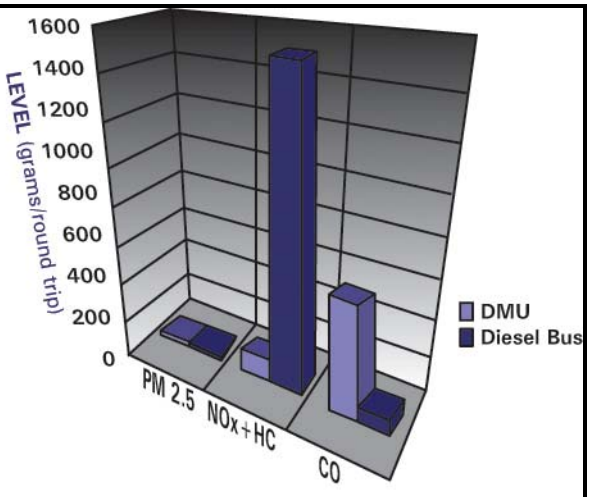
**FasTracks Vehicle Emissions**

Two modes of rail travel will be used for FasTracks Corridors—LRT and commuter rail powered either by diesel locomotion in the form of a diesel motorized unit (DMU), or by electrical multiple units (EMU). A DMU is essentially a self-propelled passenger rail car. The railcar contains both passenger seats and propulsion, in the form of diesel engines such as used in trucks, buses, or large construction equipment. An EMU is a self-propelled passenger rail car that requires electrification, such as overhead catenary or third rail. EMUs differ from light rail because they are built heavier to operate compatibly with existing standard rail and freight line infrastructure.

EMUs will not produce any atmosphere emissions in the transportation corridor. They may, however, produce emissions at the source of power production. Buses and DMUs will produce corridor emissions depending on the type of engine in the vehicle (see **Figure 23**). FasTracks commuter rail systems (EMU or DMU) will not be operational until after new diesel engine standards take effect in 2011. A 2011 DMU would emit on a per seat-mile basis the same NOX and PM as LRT and EMU vehicles powered by electricity generated in one of the cleanest power stations today. There would be localized increases of NOX and PM along the DMU corridors.

Emissions of oxides of nitrogen (NOX), particulate matter (PM10), volatile organic compounds (VOCs), carbon monoxide (CO) and carbon dioxide (CO2) are not dramatically different on a per seat-mile basis between electric rail modes and commuter rail DMUs. When the emissions from generating electricity are considered across the United States LRT and EMUs will generate emissions by drawing their electricity from the electrical grid, which may be powered by a mix of technologies including, but not limited to, coal, natural gas, hydro or nuclear. The electricity required for a 20-mile LRT system is roughly 0.04 percent of Public Service Company's peak hourly generating capacity. This translates to insignificant emissions from the slight increase in electrical demand. In 2011, anticipated EPA emissions standards will result in DMUs with PM10 and NOX emissions about equal to the emissions from

**Figure 23**
**Comparison of Diesel Bus and DMU Emissions**




| Emission Type | DMU vs. Diesel Bus |
|---|---|
| Particulate Matter (PM 2.5) | DMU < Bus |
| Oxides of Nitrogen ($NO_x$), Hydrocarbons (HC) and ozone ($O_3$) | DMU < Bus |
| Carbon Monoxide (CO) | Bus < DMU |

Note: $PM_{2.5}$ Particulate matter smaller that 2.5 microns
$NO_x$ Oxide of Nitrogen
HC Hydro carbons
Emissions in grams/round trip to provide 404 seats (DMU) and 400 seats (Diesel Bus)

electric rail vehicles operating using electricity from the cleanest plants today.

**Automobile Emissions**
In the FasTracks corridors, auto speeds will increase up to 3 miles per hour, compared to not having FasTracks in service because daily VMT will be reduced. With FasTracks in service, the expected growth in auto traffic would be about 162.5 percent. Overall, the 0.5 percent reduction created by FasTracks system is anticipated to have a modest positive contribution to the overall transit system (including RTD bus service and proposed BRT service). The result is a beneficial impact within the Denver metro area impact on regional air quality by reducing the total number 2030 weekday personal vehicle trips and weekday VMT to 474,000 fewer miles compared to not constructing new transit rail lines.

## 6. Potential Mitigation and Recommendations

Air quality emissions reduction strategies can contribute to reducing the cumulative emissions impacts due to FasTracks corridor development by implementing some or all of the following mitigation measures.

### *a. Corridor Mitigation, to be Implemented by RTD*

Maintenance and run schedules can be formulated so that idling time is at the very minimum necessary to keep the trains in proper running condition. It could also include restricting locomotive idling to certain locations where there is minimal impact to residences or human activity. These strategies have the benefit of not costing anything out of pocket, but may require shift changes by maintenance staff to accommodate the schedule.

### *b. Programmatic Mitigation, to be Implemented by RTD*

RTD developed Air Quality Mitigation strategies that consists of several potential suggestions for mitigation that could be used within the FasTracks system (FasTracks Environmental Policies and Procedures Volume II, April 2007) These include, as appropriate:

- Monitoring of $PM_{10}$ during construction.
- A three-minute bus idle limit; requiring all drivers to shut down the bus if it's idling more than three minutes.
- Purchasing and retrofitting the RTD existing vehicle fleet with emissions equipment. For its bus fleet, devices can be installed for a cost of approximately $3,000 per vehicle, which would reduce vehicle emissions.
  - RTD has modified approximately 500 buses with more efficient electronic engine controls and fuel injections. This modification has reduced emissions by approximately 90 percent. New buses (187) have been purchased that are equipped with particulate filters on the exhaust, and exhaust re-circulators that reduce the combustion temperature, thus reducing NOX.
  - RTD currently also includes several maintenance items to reduce emissions by performing periodic emission opacity testing, scheduled front end alignments to improve fuel efficiency, and optimizing transmission shifting points.

- Changing the fuel purchased for vehicles. Low-sulfur diesel is readily available, as well as additives for regular diesel. These diesel formulas significantly reduce pollutant emissions while slightly increasing fuel consumption.
- RTD is currently phasing in low-sulfur diesel fuel and soon all buses will be using low-sulfur diesel. RTD is also testing bio-diesel fuel (B20) in five buses.

RTD will also comply with any appropriate ozone-related strategies as adopted by the RAQC.

### *c. Recommendations, to be Implemented by Entities other than RTD*

Regional and local agency strategies that could be used to reduce criteria pollutant and mobile source toxics emissions, especially diesel particulate matter from existing diesel engines (such as city fleets) include: tailpipe retrofits, closed crankcase filtration systems, clean fuels, engine rebuild and replacement requirements, contract requirements, anti-idling ordinances and legislation, truck stop electrification programs, and aggressive fleet turnover policies.

In addition, there will likely be new strategies adopted for ozone reduction that could be implemented by local entities.

# E. Energy

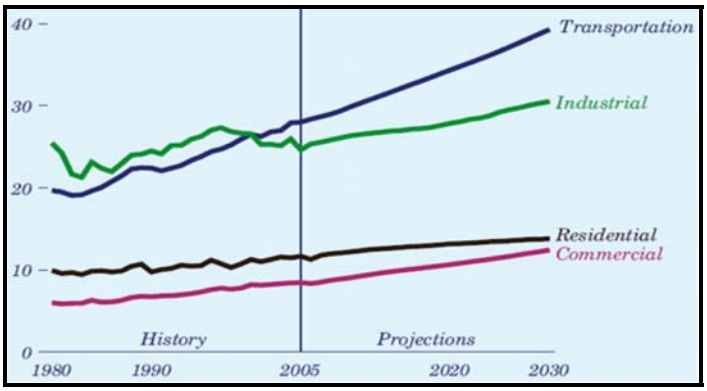
## 1. Introduction

Transportation-related energy use and vehicle miles traveled (VMT) in the Denver metropolitan area are on the rise (see **Figure 24**). Annual VMT is a measure of the total miles traveled by all vehicles on the road in a given year. Automobiles and trucks, along with an increase in population, contribute significantly to the consumption of energy and increase in VMT. Alternative transportation modes, such as those being implemented by FasTracks (bus, light rail, and commuter rail) can aid in reducing energy consumption and VMT. This section analyzes energy consumption with and without FasTracks.

**Methodology and Assumptions**

- Energy use was measured in British Thermal Units (BTUs) per vehicle-mile and calculations were based on the Federal Transit Administrations (FTA) New Starts Criteria Template.
- Energy is required for both construction and operations of FasTracks. However, because it is expected that energy use during construction of FasTracks will be of short duration it was not evaluated. Instead, this section focuses on energy consumed during transit operations.

**Figure 24**
**Energy Consumption by sector, 1980-2030 (quadrillion btu)**




*Source: Energy Information Administration, Annual Energy Outlook 2007 with Projections to 2030.*

- Energy was calculated by first subtracting the without FasTracks VMT from the with FasTracks VMT for each vehicle type. Then, that difference was multiplied by the energy consumption factor (BTU) (obtained from the Energy Data Transportation Data Book: Edition 16) to determine the change in energy consumed by vehicle type with FasTracks.
- The following vehicle modes were evaluated in terms of BTUs and VMT:
  - Passenger vehicle
  - Heavy-duty vehicle
  - Bus/diesel
  - Bus/CNG
  - Light or heavy rail/electric
  - Commuter Rail/Diesel
- To determine energy use with and without the FasTracks program, the study area was defined as the DRCOG modeling area (DRCOG, 2004).

- The scenario without FasTracks assumed transit implemented to-date: Central/Central Platte Valley, Southwest, and Southeast corridors. Although the future downtown circulator technology has not been determined it was modeled as a diesel bus and included in this analysis.

**Assumptions**

- The table generated in this analysis was based on the DRCOG's 2030 Regional Transportation Plan (RTP) model.
- Diesel commuter rail was evaluated for 2030 but it was not included in the 2007 scenario since it does not currently exist in the 'without FasTracks' program.
- The future downtown circulator was not included in this analysis as its technology has not yet been determined.
- The Future without FasTracks includes the Central, Southwest, and Southeast corridors.

## 2. Historic Conditions

Trends in energy use vary due to supply and demand. Since the 1980s, the United States energy consumption has been on the rise (see **Figure 24**). Population and travel have significantly increased over the years as well, both of which have contributed to the rise in energy use. Regional statistics in the Denver area show that VMT has increased from approximately 40 million in 1990 to over 60 million in 2005 (DRCOG, 2005).

In 1994, in the Denver Metro area, the Central Corridor light rail was implemented in an effort to provide an alternative transportation mode to the increasing population. Following the Central Corridor, the Southwest (2000) and Southeast (2006) Corridors were added to provide additional light rail service to the region. 'Before studies' were conducted to determine if the utility company providing the electricity would be able to service the increased usage of electric power. The studies found that the utility company would be able to service the additional power and the increased electricity usage would not significantly impact the generating capacity or distribution system.

The Southeast Corridor Final Environmental Impact Statement (FEIS) also found that the implementation of the light rail and widening of I-25 (known as the 2020 Preferred Alternative) would require 0.67 percent more total energy compared to not implementing the Southeast Corridor (identified as the 2020 No-Action Alternative) (see **Table 18**). This slight increase was a result of increasing light rail ridership (and the electricity requirements that correlate with that) and the widening of I-25.

## 3. Current Issues and Challenges

Highway vehicle travel in the United States accounts for approximately 85 percent of total energy consumed (EIA, 2007). An issue for all major metropolitan areas is how to decrease energy consumption in the transportation sector. The challenge for our region is to encourage ridership of public transportation while reducing single occupant passenger vehicles on the highways. Additional measures such as the availability and convenience of transit, station design, and station drop-offs should be considered in efforts to increase energy savings and reduce consumption.

**Table 18**
**Comparison of the Annual Energy Consumption for the No-Action Alternative and the Preferred Alternative (Southeast Corridor).**

| Alternative | Annual Energy Consumption in millions of BTUs | | | |
|---|---|---|---|---|
| | Gasoline | Diesel | Electricity | Total |
| **No-Action** | | | | |
| 2020 Time Frame | 149,033,841 | 20,769,505 | 168,305 | 169,971,651 |
| **Preferred Alternative** | | | | |
| 2020 Time Frame | 149,876,630 | 20,816,915 | 424,377 | 171,117,922 |
| Difference (BTU) | 842,788 | 47,410 | 256,072 | 1,146,270 |
| Difference (Percent) | 0.57 % | 0.23 % | 152.15 % | 0.67 % |

*Source: Southeast Corridor Final Environmental Impact Statement, 1999.*

## 4. Future without FasTracks

Without the implementation of FasTracks, the overall annual BTU's for the region would be 201,034,575. The total annual VMT for the region without FasTracks would be 32,656,127.**Table 19** shows the total BTUs and VMT would be higher without FasTracks than with FasTracks.

**Table 19**
**FasTracks Energy Analysis for 2030**

| Vehicle Class | Regional VMT/year (millions) | | Energy Consumption[3] | Change in BTU/ year (millions) [4] |
|---|---|---|---|---|
| | Without FasTracks | With FasTracks[7] | (BTU/VMT) | With FasTracks vs. Without FasTracks |
| Passenger Vehicle[1] (LDV/LDT) | 31,922.587[5] | 31,764.210 | 6,233 | -987,161.720 |
| Heavy-Duty Vehicle[1] | 687.080 | 687.080 | 22,046 | No change |
| Bus/Diesel[2] | 42.252[5] | 51.428 | 41,655 | 382,240.174 |
| Bus/CNG[2] | 0.335 | 0.335 | 41,655 | No change |
| Light or Heavy Rail/Electric[2] | 3.873[6] | 7.154 | 77,739 | 255,083.154 |
| Commuter Rail/Diesel[2] | | 2.459 | 95,000 | 233,605.000 |
| Commuter Rail/Electric[2] | | | 95,000 | No change |
| **Total** | | | | **-116,233.392** |

*Source: DRCOG's 2030 Regional Transportation Plan model; RTD FasTracks, 2007.*

*Notes: Bus VMTs are not equal to passenger vehicle VMTs since buses have a higher per person carrying capacity.*

*[1] Passenger vehicle calculations based from regional travel forecasting model.*

*[2] Bus and rail based from system operating plans.*

*[3] Energy consumption constant derived from Transportation Energy Data Book: Edition 16.*

*[4] Change in BTU/year derived from following equation: = Change in VMT/year * BTU/veh-mi*

*[5] Passenger vehicle and diesel bus VMT Without FasTracks is calculated by multiplying With FasTracks VMT by the ratio of Without to With VMT from the 2004 FasTracks Plan.*

*[6] Light rail VMT for Without FasTracks is equal to projected 2007 LRT VMT for the existing LRT system from RTD's Service Summaries report for January 14, 2007.*

*[7] All With FasTracks VMT figures are taken from the WCBldLRT30i model run used for the October 2006 New Starts submittal for the West Corridor.*

## 5. Potential Mitigation and Recommendations

Although the FasTracks program will not result in a large reduction in energy consumed or VMT, future efforts should attempt to encourage fewer passenger vehicles on the road and fewer vehicle miles traveled.

### *a. Corridor Mitigation, to be Implemented by RTD*

See programmatic suggestions below.

### *b. Programmatic Mitigation, to be Implemented by RTD*

Efforts to reduce energy consumption and overall VMTs should be continued in the design of transportation systems, use of energy efficient transportation technologies, and other sustainable practices such as:

- Creating multiple access points for parking lots.
- Carefully designing “kiss and ride” drop-offs to maximize efficiency and minimize number of vehicles idling.
- Positioning stations to be more easily accessible by pedestrians and bicyclists.
- Locating stations near multi-family dwellings.
- Park-n-Ride improvements to decrease energy consumption consistent with RTD’s sustainability policy.

### *c. Recommendations, to be Implemented by Entities other than RTD*

Xcel Energy has a variety of Conservation Programs that local agencies and other businesses could incorporate. For example, at RTD’s Colfax bus facility, carbon monoxide sensors are in use, which Xcel estimates saves 420,000 kWh per year. At 1601 Market Street, energy efficient motors and variable frequency drives (VFD) have been installed. The average savings for these technologies has been approximately 120,000kWh per year which equates to $7,200 per year. There is also a $3,000 rebate for implementing such devices.

Local jurisdiction could also adopt programs to encourage use of alternate modes to access the FasTracks system.

# F. Surface Waters, including Wetlands

## 1. Introduction

Wetlands are described by the U.S. government, according to 33 CFR 328.3(b) of the U.S. Army Corps of Engineers Regulatory Program Regulations, as "…those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (Mitsch and Gosselink, 1993). Wetlands provide many functions that are valuable to the human environment.

Surface waters are defined in this document as all other aquatic features that may be found in the cumulative study area. These surface waters include, but are not limited to, rivers, streams, ditches, ponds, lakes, or wetlands.

**Methodology and Assumptions**

- Streams, rivers, and lakes/ponds were assumed to have a wetland fringe unless there were obvious concrete or rip-rap lined shores.
- All wetlands within the 300-foot buffer of each alignment were assumed to be impacted by FasTracks.
- There would be no indirect impacts to wetlands from induced growth around stations that are in urban areas that are already fully developed.
- In those corridors that do not have wetland delineations completed, all wetlands and surface waters were counted in the impact totals.
- The "area-type" maps from DRCOG are indicative of future growth around the end-of-line stations. Wetland impacts delineated as part of the EISs currently underway were collected in 2006 and 2007. These corridors include: Gold Line, East Corridor, West Corridor, and Northwest Rail. With the exception of the West Corridor, which delineated approximately 100 feet on either side of the proposed alignment, wetlands were delineated within 300 feet of the proposed corridors. North Metro impacts were calculated using the vegetation layer from the Colorado Division of Wildlife (CDOW) Natural Diversity Information Source (NDIS) riparian mapping Geographic Information System (GIS) data (CDOW 2006). These impact acreages are shown in **Table 20** on page 85.
- A 300-foot buffer around the corridors that do not have current wetland impact information was overlaid onto a 2006 aerial photo. These corridors are the SW Extension, SE Extension, and I-225.
- Aerial photographs provided the base information in GIS. Through aerial photo interpretation polygons were drawn around potential wetlands within the 300-foot buffer for each corridor. Streams, rivers, and lakes/ponds were assumed to have a wetland fringe unless there were obvious concrete or rip-rap lined shores. The areas of these wetlands were calculated for each remaining corridor.

## 2. Historic Conditions

### *a. Quantity of Wetlands*

Since 1950, the amount of wetlands located in the Denver Metro region has decreased, mainly due to changes in land use as described earlier in this document. Development pressures have steadily increased over the last few decades in the region. Before there were regulations to protect surface waters, including wetlands, many acres of wetlands were converted into residential subdivisions or commercial property. Other sources of wetland loss around the region include: dewatering for irrigation, livestock overgrazing, stream channelization, dewatering for municipal and industrial use, and contamination from sewage and industrial waste (EPA, 2006). Historically, Colorado's wetlands only accounted for 3 percent of the surface area of the state. However, up to 50 percent of those wetlands have been lost, which is proportionately greater than other habitat type losses in Colorado.

Another reason for a decrease in wetland acreage is due to a Supreme Court ruling in 2001 which stated that the Corps does not have authority under the Clean Water Act to protect "isolated" wetlands. Unless a state or local government implements its own protection programs, these resources are subject to filling and dredging without requirements to mitigate. With the exception of the City of Boulder, no other surrounding municipalities have implemented surface water and wetland protection regulations. This circumstance has allowed many acres of isolated wetlands to be filled and permanently lost in response to increased development demands.

Wetland mitigation has been required by the Corps since the late 1970's, and failure of wetland mitigation sites been an issue since that time. In 1996, the National Wildlife Federation testified before the Senate Committee on Environment and Public Works that 50 percent of all wetland mitigation is a failure (EPA, 1998). Often, investigation and studies of the potential mitigation site were conducted improperly and issues with maintaining hydrology of constructed wetlands arose. In addition, if regular maintenance and upkeep of these wetlands is not done, the potential for invasive species taking over the wetlands becomes high and puts the wetland in danger of becoming a monoculture. Because of this and the lack of required mitigation for isolated wetlands, wetland loss has occured in the region.

The existing light rail corridors in the Denver area are the Central Platte Valley, Southeast Corridor, and Southwest Corridor. The wetland impacts from these corridors were as follows:

- The Central Platte Valley light rail did not have any jurisdictional wetland impacts.
- The Southwest Corridor impacted less than 0.5 acre of wetlands.
- The Southeast Corridor impacted 32 wetlands and 8 streams for a total of approximately 1.4 acres of wetlands.

The Southeast Corridor mitigated for all stream and wetland impacts, regardless of Corps of Engineers jurisdiction, through a combination of on-site mitigation and wetland mitigation banking. The reason all wetland impacts were mitigated is that this is a requirement of DOT Order 5660.1A and since T-REX was federally funded, mitigation for both types of wetland impacts was provided.

### *b. Wetland Quality*

The quality of wetlands in the region has also decreased over the last 50 years. Invasive and non-native species, such as reed canary grass and giant reed, have turned once diverse wetlands into monocultures. The invasive and non-native species have outcompeted the valuable native vegetation that was once found in these wetlands. In addition to degradation from invasive species, the increase in impervious surfaces due to development has increased pollutants and sediment that flow into the wetlands. While wetlands have the ability to trap sediment and filter pollutants, there is a limit to how much these systems can handle.

As development increased in the Denver area, the functions of wetlands affected by development were either lost completely or degraded. This includes habitat for threatened and endangered (T&E) species such as the Preble's Meadow Jumping Mouse, which lives near streams, often near riparian wetlands. Habitat for T&E species has been lost or converted into unsuitable habitat through the loss and degradation of wetlands. Wildlife populations have also been fragmented, through the destruction of portions of large wetland areas. The remaining wetland areas may not have been large enough to support a species' population, thus eliminating the habitat for that species.

## 3. Current Issues and Challenges

Many of the same issues that historically affected wetlands still affect wetlands today. Failure of wetland mitigation sites is still occurring. If wetland mitigation fails, the purpose of mitigating impacted wetlands at a 1:1 ratio is lost. The concept of "no net loss," which implies that the overall acreage of wetlands in the U.S. is not decreasing due to mitigation, is defeated when mitigation sites fail. The Corps of Engineers actively monitors constructed wetlands, however, and requires action to make sure mitigation is successful.

Another issue still facing wetlands is that, as discussed earlier, with the exception of the City of Boulder and the City of Greenwood Village, there is no protection or required mitigation for non-jurisdictional wetlands. The Corps does not have the authority to regulate non-jurisdictional wetlands and those wetlands are in constant danger of being impacted without any required compensatory mitigation. In addition, due to new guidance that was recently issued by the Corps and EPA headquarters, the process for determining jurisdictional determinations for wetlands has changed.

### *a. Quantity of Wetlands*

Without required mitigation for all wetlands, the concept of no-net-loss is not feasible for wetland impacts.

### *b. Wetland Quality*

Wetland quality is also decreasing, as discussed earlier, due to increased impervious surfaces and development in the Denver metro region.

## 4. Future without FasTracks

"Area-type" maps provided by DRCOG for the future conditions without FasTracks and with FasTracks were analyzed in the Land Use section of this document. The 2030 "area-type" maps for the future situation without FasTracks are very similar to the "area-type" maps for the future situation with FasTracks. This implies that regardless of whether FasTracks is constructed or not, growth and development will continue to occur in the Denver Metro region. Due to this

growth without FasTracks, which would not have the denser development around stations, the potential for wetland impacts in the study area is greater than without FasTracks.

### *a. Quantity of Wetlands*

The future situation without FasTracks has the potential to indirectly impact more wetlands than with FasTracks. This is because many of the stations under the FasTracks program are slated for Transit Oriented Development (TOD). TOD sites will result in denser developments and multi-use station areas. This change in land use should have the effects of reducing urban/suburban sprawl. Denser development leads to fewer wetland impacts since the development will be occurring in a smaller area, thus leaving more opportunities to preserve open space and wetlands. Without TODs the potential for urban and suburban sprawl in these areas would be greater, along with the potential for impacts to wetlands.

### *b. Wetland Quality*

The future quality of wetlands will depend on the types of development that occur near wetlands. Without FasTracks, the development that would occur in or near the station areas would likely not follow the same principles of TODs. This could result in more sprawl and impervious surfaces throughout that development, rather than a concentration of development. Indirect impacts to wetlands have the potential to be greater without FasTracks as sprawling development would occur. However, if municipalities and developers implement best management practices (BMPs) throughout their developments, the impacts to wetland quality can be minimized.

## 5. Future with FasTracks

In January 2006, a Memorandum of Agreement was signed by the Federal Transit Administration, Region 8, and the Corps to describe the mutually-agreeable procedure for applying for an individual Section 404 permit and for merging the FasTracks NEPA requirements with the NEPA requirements that the Corps has. This MOA clearly outlines the procedures for FTA-led corridor projects and provides guidance to each of the corridor teams.

### *a. Quantity of Wetlands*

The impacts from the corridor alignments are shown in **Table 20**.

Because the cumulative study area has such narrow boundaries for each corridor, impacts from other public or private projects were not calculated.

Based on the analysis, indirect impacts will occur to wetlands as a result of FasTracks around the stations on each corridor. These impacts will result from growth around the stations. Based on assumptions of growth in the Denver metro region over the next 25+ years, wetland impacts will continue to occur. However, with the potential for TOD around stations along the corridor and end-of-line stations, new development will be denser and the likelihood of urban/suburban sprawl will decrease. Denser development will lead to fewer wetland impacts since the development will be occurring in a smaller area, thus leaving more opportunities to preserve open space and wetlands.

**Table 20**
**FasTracks Approximate Wetland Impacts**

| Corridor | Wetlands (Yes/No) | Corridor Wetland Impact (acres) |
|---|---|---|
| Denver Union Station (Phase I) | No | 0 |
| West Corridor | Yes | 1.26 |
| East Corridor | Yes | <0.5 |
| Gold Line | Yes | 0.2 |
| I-225* | Yes | 3.8 |
| North Metro* | Yes | 10 |
| NW Rail | Yes | 1.8-2.7 |
| SE Extension* | Yes | 0.62 |
| SW Extension* | Yes | 0.44 |
| US 36 | Yes | 20.4-27.5 |
| **Total for FasTracks Rail Projects** | | 18.6-19.5 |
| **Total for FasTracks Multi-Modal Projects** | | 20.4-27.5 |
| **Total** | | 39.1-47.1** |

**Delineation not completed as of June 2007. Estimates completed through aerial photo interpretation or vegetation mapping.*

***A large portion of these impacts are highway related.*

*NOTE: These estimated acreages should not be used for permitting or mitigation purposes.*

This table addresses all wetlands regardless of U.S. Army Corps of Engineers jurisdiction under Section 404. Impacts to rivers, streams, lakes, and ponds are not yet known.

**Table 21** assesses the potential for wetland and stream impacts at stations with opportunities for transit and oriented development (TOD). Some segments of the corridors will have stations that will be in more urban areas and are already fully developed around the stations. These stations are therefore less likely to have an impact on wetlands from induced growth and were not counted as having the potential to indirectly impact wetlands from induced growth. An area was rated as “low” if there were very few small drainages or wetlands visible on the aerial photo, or if an area was mostly developed, with little chance of TOD or redevelopment. “Moderate” areas have larger waters of the U.S. within them, or appear to have several wetlands. “High” areas have numerous wetland areas or several waters of the U.S. If a station has a planned development in the station area, the potential for impacts to wetlands was rated greater than if there is no planned development.

Any named creeks, ditches, or tributaries were listed in the table if there is a potential for indirect or direct impacts to them.

**Table 21**
**Potential for Wetland and Stream Impacts at Stations***

| Corridor | Station | Potential for Wetland and Stream Impacts | TOD Opportunity |
|---|---|---|---|
| East Corridor | Stapleton | Moderate—Sand Creek | Immediate |
| | Peoria/Smith | Low—Small, unnamed drainage ditch | Mid-Term |
| | Airport Blvd/ 40th Avenue | Low—Highline lateral ditch | Immediate |
| | DIA | Low—Small, unnamed ditch | No opportunity |
| Gold Line | 38th Avenue | Low—South Platte River | Immediate to Mid-term |
| | Pecos | Moderate—Fisher Ditch and Clear Creek | Mid-term |
| | Federal | High—Clear Creek and Fisher Ditch | Mid-term |
| | Sheridan | Moderate—Ralston and Clear Creeks | Mid-term |
| | Olde Town | Low—Ralston Creek | Immediate |
| | Arvada Ridge | Moderate—Swadley, Reno, and Slough Ditches | Immediate |
| | Ward Road | Moderate—Swadley and Reno Ditches | Mid-term |
| I-225 | Fitzsimmons Commons | Moderate—Tollgate Creek | Immediate |
| | Fitzsimmons South | Moderate—Tollgate Creek | Immediate |
| | 4th Avenue | Moderate—Highline Canal | Immediate |
| | Aurora City Center | Moderate—Highline Canal | Immediate |
| | City Center/Exposition | Low | Immediate |
| | Iliff | Low | Immediate to Mid-term |
| | Nine Mile | Low—near Cherry Creek Reservoir | Immediate to Mid-term |
| North Metro | Globeville/ Swansea | Moderate—South Platte River | Long-term |
| | Commerce City | High—South Platte River, Sand Creek, and Burlington Ditch | Immediate to Mid-term |
| | 88th | Moderate—Lower Clear Creek and Agricultural Canal | Immediate |
| | 100th | Moderate—Lower Clear Creek and Agricultural Canal | Mid-term |
| | 112th | High—Tributary to Hail Creek and associated wetlands | Mid-term |
| | 124th | High—Several drainage ditches and associated | Immediate |

**Table 21**
**Potential for Wetland and Stream Impacts at Stations***

| Corridor | Station | Potential for Wetland and Stream Impacts | TOD Opportunity |
|---|---|---|---|
| | | wetlands | |
| | 144th | Moderate—Signal Ditch | Mid-term |
| | 162nd | High—German Ditch and Big Dry Creek | Immediate to Mid-term |
| Northwest Rail Corridor | 71st Avenue/Lowell | Moderate—Little Dry Creek | Immediate |
| | Flatiron/96th Street | Moderate—Area is currently being developed, impacts from induced growth unlikely | Immediate to Mid-term |
| | Louisville | Low | Immediate |
| | 30th and Pearl | Low—very developed | Immediate |
| | IBM @ Diagonal Highway | Moderate—Dry Creek | Mid-term |
| | Twin Peaks Mall | Moderate—Clover Basin Ditch and Wiswall Creek | Immediate |
| Southeast Corridor Expansion | Sky Ridge | High—Willow and Cottonwood Creeks, Arapahoe Canal | Mid-term |
| | Lone Tree Town Center | High –Cottonwood Creek and Arapahoe Canal | Immediate |
| | RidgeGate Parkway | High—Happy Canyon and Cottonwood Creeks, Arapahoe Canal | Immediate |
| Southwest Corridor Expansion | C470/Lucent Boulevard | High—Highline Canal and associated wetlands | Immediate to Mid-term |
| US 36 | Westminster Center | Moderate—Allen Ditch | Immediate |
| | US 36 and Church Ranch | Moderate—Walnut and Big Dry Creeks | Immediate |
| | Broomfield | Low - Area is currently being developed, impacts from induced growth unlikely | Immediate |
| | Flatiron/96th Street | Moderate—Area is currently being developed, impacts from induced growth unlikely | Mid-term |
| | US 36 and McCaslin (Superior) | Moderate—Coal Creek | Mid-term to Long-term |
| | Table Mesa | Moderate | Long-term |
| West Corridor | Sheridan | Moderate—Two branches of Dry Gulch | Immediate |
| | Lamar | Moderate—Two branches of Dry Gulch | Immediate to Mid-term |
| | Oak | High—Lakewood and two unnamed ditches and associated wetlands | Immediate to Mid-term |

**Table 21**
**Potential for Wetland and Stream Impacts at Stations***

| Corridor | Station | Potential for Wetland and Stream Impacts | TOD Opportunity |
|---|---|---|---|
| | Denver Federal Center | Moderate—Welch Ditch and small wetlands | Immediate |
| | Red Rocks Community College | Low—Unnamed drainage | Mid-term to Long-term |
| | Jefferson County Government | Low | Mid-term to Long-term |

Those stations without strong opportunities for TOD have the potential to induce sprawl if the areas around the stations are fairly undeveloped. Those stations with strong TOD potential have the opportunity to preserve and enhance existing wetlands with denser development around the stations. This is especially relevant around stations with a high potential for wetland impacts.

### *b. Wetland Quality*

As mentioned in the Future Without FasTracks, the quality of wetlands will depend on the types of development that occur near wetlands. The station areas that use TOD and best management practices will have a smaller footprint of growth. If BMPs are implemented along with TOD, the impact from this growth is even further minimized. In addition, the track lines will remain impervious surfaces. This will allow water to infiltrate back into the ground rather than allow potentially polluted runoff to into enter wetlands, which would have the potential to degrade the quality.

## 6. Potential Mitigation and Recommendations

### *a. Corridor Mitigation, to be Implemented by RTD*

It will be up to each individual corridor, in coordination with the Corps and EPA, to determine which type of mitigation is suitable for that corridor.

### *b. Programmatic Mitigation, to be Implemented by RTD*

RTD drafted a Wetland Mitigation Strategy for the FasTracks Program that the corridors may use as guidance to determine the best possible mitigation for their corridor. (FasTracks Environmental Policies and Procedures Volume II, April 2007) Among the eligible wetland mitigation options are the following:

- Wetland restoration
- Wetland establishment (creation)
- Wetland enhancement
- Wetland protection/maintenance
- Wetland mitigation bank

The Corps and EPA generally prefer on-site mitigation. The mitigation guidance describes the steps that can be taken to determine the best option(s) for compensatory mitigation, which includes determining if on-site mitigation is available and if the site will sustain a wetland, if constructed. The guidance also provides contact and basic information about wetland banking

and the available banks in the Denver Metro region. If purchasing credits from a bank is the best option, those credits should be purchased from a bank within the same watershed in which the impacts occurred, if available.

### *c. Recommendations, to be Implemented by Entities other than RTD*

To lessen the amount future wetland impacts that are caused by development from entities outside of RTD, such as municipalities and counties, it is recommended that local jurisdictions require large future developments to incorporate existing wetlands into greenbelts or open space as an alternative to filling the wetlands. In addition, during the development process, measures should be taken to first avoid impacts to surface waters and wetlands and if avoidance is not possible, impacts to these features should be minimized to the maximum extent practicable.

Smart-growth principles, which incorporate high-density developments, are encouraged where possible. These types of developments allow the same population growth as traditional developments, but allow more land, including wetlands, to be preserved. This will not only preserve existing wetlands, but could be a cost effective solution to the permitting and mitigation processes.

# G. Social and Environmental Justice

## 1. Introduction

This section describes the demographic characteristics of the region, beginning with a historical overview, followed by an evaluation of current issues and challenges. The future conditions without FasTracks are compared to the future conditions with FasTracks. The findings show that FasTracks will provide many benefits including transportation mobility and accessibility to residential neighborhoods, employment centers and community facilities.

**Methodology and Assumptions**

- Environmental Justice Executive Order 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects on minority and low-income populations.
- This analysis includes an evaluation of the impacts (positive and negative) of the FasTracks program to low-income, minority, elderly and transit dependent populations.
- The source of data for the Social and Environmental Justice analysis included primarily U.S. Census 2000 data and Year 2005 Traffic Analysis Zone (TAZ) data from DRCOG.
- Since detailed mapping to the Census tract level is not available for future years, Year 2000 provided a recent picture of the demographic character of the region.
- The FasTracks corridors were analyzed against trends for the entire region.
- Half-mile buffers around stations were evaluated for minority and low-income projections.

## 2. Historical Trends

According to the Census 2000, the population in the Denver region grew 86 percent between 1970 and 2000. This represents an almost doubling in population growth between these three decades, with an increase of 1.1 million people. The 2000 population for the Denver-Boulder Metropolitan Statistical Area (MSA) was 2.6 million (U.S. Census 2000). Estimates of the population in 2007 is 2.6 million. Denver's population has grown from approximately 416,000 in 1950 to over 566,000 today, making it the largest jurisdiction in the MSA.

Historically, the Denver region had been served by transit through the RTD bus system. In 1994, rail service began with the Central Corridor (5.3 miles in length). The second segment, the Southwest Corridor, opened in 2000 with 8.7 miles of light rail transit (LRT) extending from Denver to Littleton. In 2006, the Southeast Corridor LRT project was completed, adding 19 miles of light rail parallel to I-25.

The Central Corridor or "D" Line runs from 30th Avenue/Downing Street through the Five Points neighborhood and business district, through downtown and to I-25/Broadway. The Southwest Corridor (C Line) extends from I-25/Broadway southwest to Littleton. The existing LRT system serves higher education facilities such as the downtown Auraria Campus and the University of Denver, as well as major retail destinations (16th Street Mall, Denver Pavilions, Convention Center) and employment centers.

Evaluation of the social and environmental justice impacts from the existing light rail system includes an analysis of the displacements that resulted from these projects. The RTD C-Line Light Rail system displaced two businesses and three parcels of industrial land (a combined 6 acres). The Southwest Corridor required acquisition of ten businesses within eight commercial buildings.

Although some displacements resulted from construction of the existing light rail system, the benefit to the region due to improvements in transportation mobility and congestion relief was substantial. The addition of LRT to the region has provided a transportation alternative to the automobile, particularly for low-income, minority and transit dependent populations. The construction of FasTracks will further improve accessibility and alternative modes of transportation, as described below.

## 3. Current Conditions and Challenges

### *a. Demographics*

According to the Census 2000, the population in the Denver region grew 86 percent between 1970 and 2000. This represents an almost doubling in population growth between these three decades, with an increase of 1.1 million people. The Denver-Boulder-Greeley Metropolitan Statistical Area (MSA) encompasses five counties in the region: Adams, Arapahoe, Denver, Douglas and Jefferson, as well as Boulder, Longmont and Greeley. The MSA had a 2000 population of 2,581,506 and 1,003,218 households. The 2000 Census estimates that, in 2006, the population of the City and County of Denver was 566,974, making it the 27th most populous U.S. city.

According to census estimates, 94 percent of the population in the MSA lives in urban areas and 6 percent lives in rural areas. The average household size is 2.53.The racial makeup of the region is 80 percent White, 5 percent Black, 3 percent Asian American, 1 percent American Indian, <1 percent Pacific Islander, 8 percent Other Race and 3 percent from two or more races.

The term “Hispanic” is considered an ethnic designation since Hispanic populations may be of any race. As a result, the number of Hispanic persons is included in both the Hispanic data set and the race data set in the Census Bureau data. Because of this, the data was separated so that Hispanic persons were not double counted. According to census estimates, 19 percent of the population in the MSA was Hispanic in 2000. Approximately 32 percent of the population was Hispanic in the City and County of Denver in 2000, which represents an increase of 68 percent between 1990 and 2000.

The median household income in 2000 in the MSA was $51,088 and in the City of Denver was $39,500. The per capita income in the MSA was $26,011 and in the City of Denver was $24,101 (Census 2000).

Denver has the one of the highest populations of baby boomers in the country. The aging population represents a large segment of the community that will likely become more transit dependent in the future.

### *b. Mobility*

The traditional pattern of development in Denver and cities across the country has consisted of new construction on greenfields in the suburban fringe. This pattern of development can lead to

longer commutes and dependence on the automobile. According to a recent Smart Growth America Report, the average daily miles driven per person in the Denver PMSA is 22.1. According to the Census 2000, approximately 4.3 percent of commuters use transit to access work, 0.7 percent bicycle and 2.4 percent walk. The average commute in minutes is 26, which is higher than many other parts of the country.

Sprawl is characterized by low-density development; rigidly separated homes, shops, and workplaces; a roadway network with huge blocks and poor access; and a lack of well-defined activity centers. Sprawl affects the social fabric of a region, and leads to decreased mobility over time. The impacts of sprawl, as defined in the Smart Growth America Report, include:

- Higher rates of driving and vehicle ownership. Cars are driven longer distances per person than in places with lower-than-average sprawl.
- Increased levels of ozone pollution. The degree of sprawl is more strongly related to the severity of maximum ozone days than per capita income or employment levels. The difference in ozone peaks appears significant enough to potentially mean the difference between reaching or failing to meet federal health-based standards.
- Depressed rates of walking and alternative transport use. In more sprawling areas, commuters are less likely to take the bus or train or to walk. If alternative transportation is not available, residents have less flexibility and are limited to using vehicles for work and non-work trips.

## 4. Future Without FasTracks

### *a. Demographics*

Population projections by DRCOG predict that the regional population will grow from 2.3 million in 2000 to 3.2 million in 2020, an increase of 38 percent over the next twenty years. Therefore, the Denver region will need to accommodate a large number of new residents. Various factors will affect how this increase in population will be shaped over time, including the location of housing for new residents. If FasTracks is not built, there will not be an opportunity to build mixed-use development with affordable housing around transit stations. There could be less demand for multi-family housing and a greater demand for single-family housing. However, the aging population trend would continue with or without FasTracks, and this will create a demand for additional multi-family and senior housing to meet the population's needs.

#### i. Housing

Regional trends show that the residential housing market has slowed in recent years. Foreclosures reached record highs with single-family homes on the market for longer periods of time. This has placed greater pressure on the rental housing market to accommodate residents moving from home ownership to rental housing. Multi-family housing permits have increased, however a large percentage include high-end loft housing in the urban core.

### *b. Mobility*

Transit accessibility to jobs, shopping and services for low-income, minority and/or elderly residents will be limited if FasTracks is not built. Residents would be served by the bus and light rail system currently in place. Traffic congestion would worsen over time, making it more difficult and time-consuming to reach jobs, shopping and services. Access to key facilities such as

hospitals, government facilities and cultural establishments would not be improved other than through transit service improvements planned without FasTracks.

## 5. Future with FasTracks

The FasTracks transit corridors may result in residential and commercial displacements which would not otherwise occur if FasTracks was not built. These impacts are further described below.

### *a. Demographics*

Although FasTracks may not lead to an increase in the population of the region, FasTracks will be a key factor in shaping the direction of future growth. The population is expected to increase in terms of racial and ethnic diversity in the future, and will experience a substantial increase in the elderly population. FasTracks will provide more opportunities to construct a variety of housing options to meet the needs of this diverse population.
The following discussion describes the future with FasTracks as it relates to housing, service to minority, low-income and elderly populations, and service to major activity centers across the region.

#### i. Housing

FasTracks has the potential to shift the housing densities to locations around transit stations. However, it is the local jurisdictions' responsibility to ensure that new housing accommodates all income levels and diversity in demographic populations. A strong market for rental housing is needed to maintain a balance and diversity in housing around stations.

According to a recent Report, "The Case for Mixed-Income Transit-Oriented Development in the Denver Region" (March 2007), there are approximately 45,000 households that live within one-half mile of an existing light rail stop today. By the year 2030, this number could triple to more than 155,000 households. This could translate to a demand of 1,600 additional housing units at each station area. At least 40 percent of this demand will come from low-income households (those with incomes less than 80 percent of the area median income, or $51,600 for a family of three in 2006).

As the FasTracks corridors are built, property values near stations are anticipated to change over time. National trends show that property values increase if the property is located within a ½ mile of a transit station. If low-income and minority populations currently live in close proximity to a proposed station, their property values are anticipated to increase with FasTracks. As property values increase and redevelopment occurs over the long term, minority and low-income populations may be forced to live farther from stations and farther from transit service.

#### ii. Minority Populations

The U.S. Census Bureau represents the most widely accepted data source for environmental justice analyses. For purposes of this analysis, Census Data (Year 2000) were used at the tract level to determine race and ethnicity within the study area. Race categories include White, African-American, Asian, American Indian and Alaskan Native, Native Hawaiian or Other Pacific Islander. **Figure 25** shows the concentration of minorities by Census tract across the region. To simplify the data, the minority category includes all populations other than White.

**Figure 25** shows that minority concentrations in the inner part of the region will be well served by FasTracks. The East Corridor and West Corridor will have the highest number of stations

(approximately three to five stations per corridor) located in minority neighborhoods. Many end of line stations, such as the West Corridor (Golden), US 36 BRT (Boulder) and Northwest Rail Corridor (Longmont) would serve tracts with 20 percent or more minority populations. The Southeast and Southwest corridors would serve the fewest minorities; however, this could change in the future with new development surrounding stations, including housing.

### iii. Hispanic Populations

FasTracks will enhance mobility for minority and Hispanic populations by improving access to job centers and services across the region, as well as access to other modes of transportation (see **Figure 26**). Rail services converging at Denver Union Station will provide access to the regional bus system when the Market Street station is relocated to the Denver Union site. Linkages will also be made to commercial carriers.

### iv. Income and Proximity to Transit

DRCOG collects data for the region by Traffic Analysis Zone (TAZ). TAZs are based on a trip generation model, and provide calculations on land use, economic and travel characteristics for the region. TAZs calculate households by income level, and are divided into low, medium and high categories. The income levels are as follows:

- Low: Under $15,000 (income per household)
- Medium $15,000-$75,000
- High: Greater than $75,000

**Figure 25**
**Minority Populations**

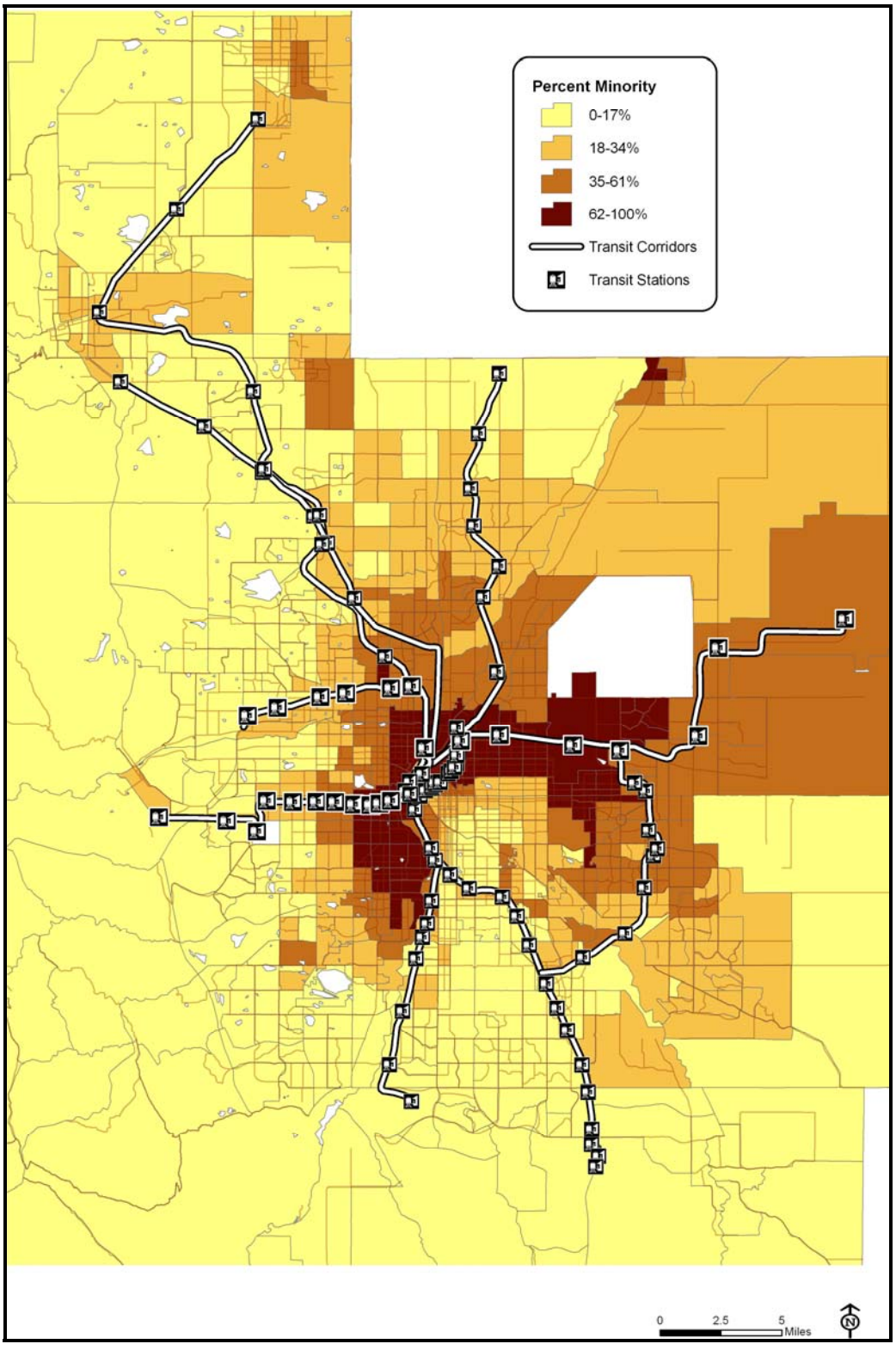


**Figure 26**
**Hispanic Populations**

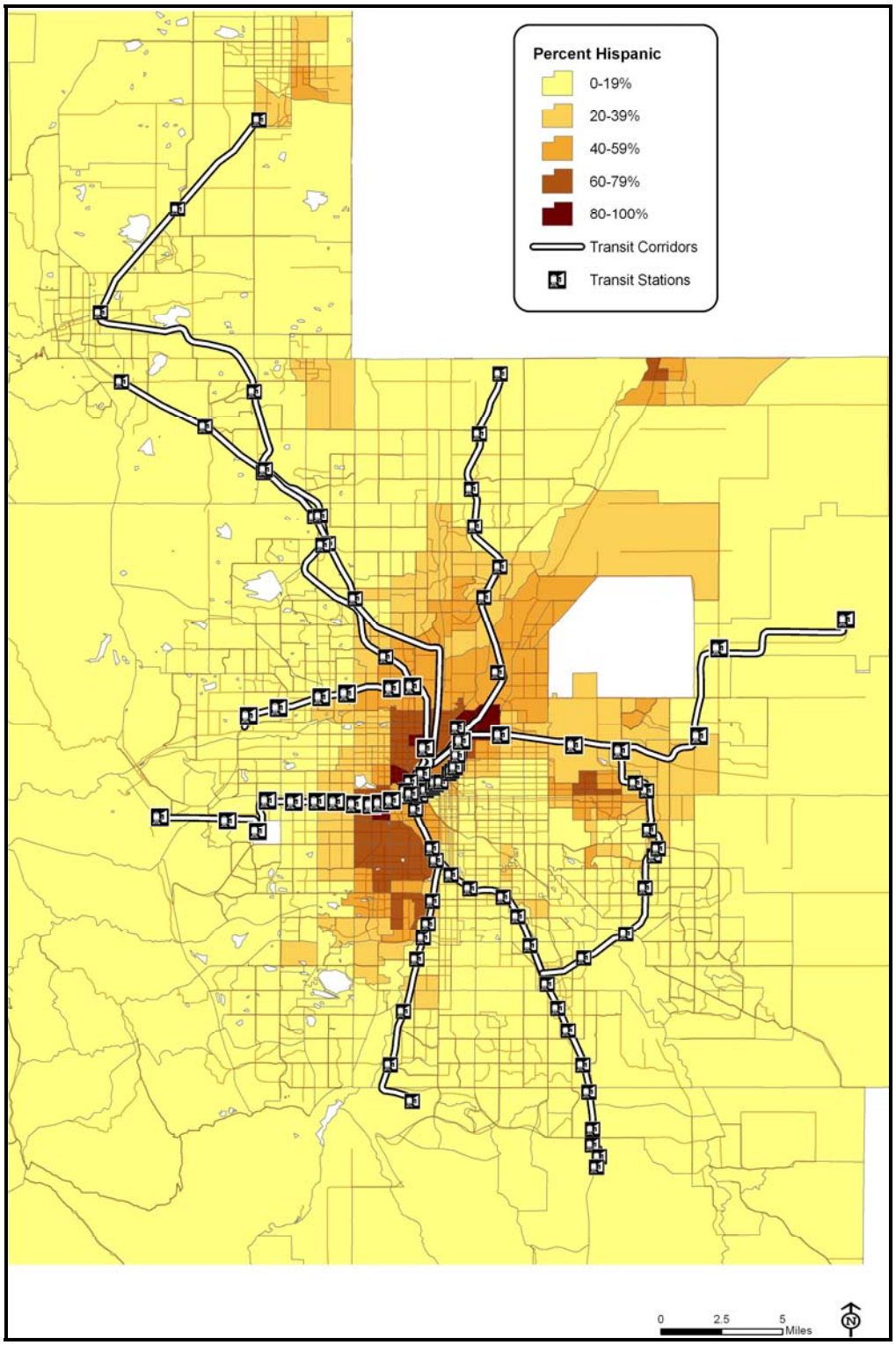


**Figure 27** shows the number of low-income households in each TAZ for the year 2005. The map shows that most of the stations along the I-225, Gold Line, and West Corridors are within ½ mile of TAZs with greater than 100 low-income households. Across the system, over 30 of the 57 stations planned are located in areas with a high number of low-income households. Figure 29 shows that while the FasTracks rail alignments will cross through a number of low-income areas within the region, there are many neighborhoods that will not be served directly by rail transit. Therefore, many populations will depend on an enhanced bus system, planned as part of FasTracks, to reach employment and other destinations in the metro area.

FasTracks transit stations will be located near major job sites, which could provide better and more convenient access for low-income and minority persons. **Table 22** shows improvements in transit access for areas in the region with high concentrations of low-income and minority persons.

**Table 22**
**Number of Jobs within a 45-Minute Transit Trip (2025)**

| Area | Without FasTracks | With FasTracks |
|---|---|---|
| Five Points | 251,000 | 299,000 |
| Alameda/Federal | 187,000 | 312,000 |
| Peoria/Colfax | 85,000 | 189,000 |
| Commerce City | 45,000 | 89,000 |

*Source: Review of RTD FasTracks Plan, April 2004, DRCOG*

### v. Advanced Age and Transit Dependent Populations

Denver has one of the highest populations of retirees in the country. This trend is expected to continue in the future. According to Census 2000 data, advanced age populations (age 65 and over) are concentrated in the southern and western portions of the region (south of I-70 and west of I-25). The Southwest, West and Gold Line corridors will be located in proximity to the majority of advanced age populations in the region. The populations in TAZs above 60 percent, shown in **Figure 28**, represent retirement communities.

According to DRCOG, the region receives only 47 percent of state and federal Older Americans Act funding for aging services across the state, despite having almost 52 percent of the population age 60 and over. Additionally, 52 percent of the state's low-income and minority seniors live in the metro area. The aging population places pressure on senior services, such as home delivered meals. The transit improvements with FasTracks will assist senior populations in reaching destinations across the region to meet their needs, and will improve the capability of service providers to reach senior populations (Source: DRCOG State of the Region, 2007).

**Figure 27**
**Low-Income Populations**

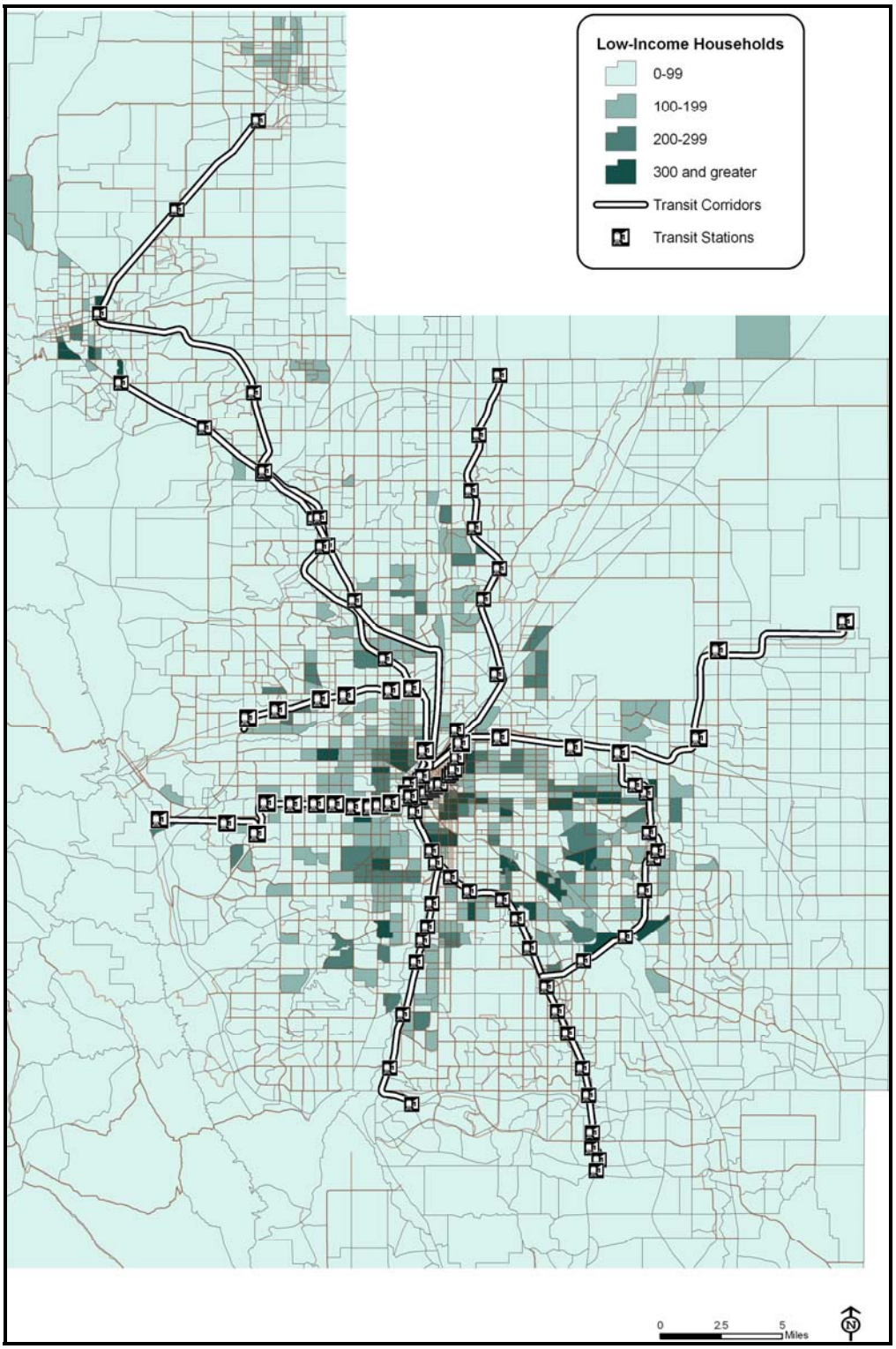
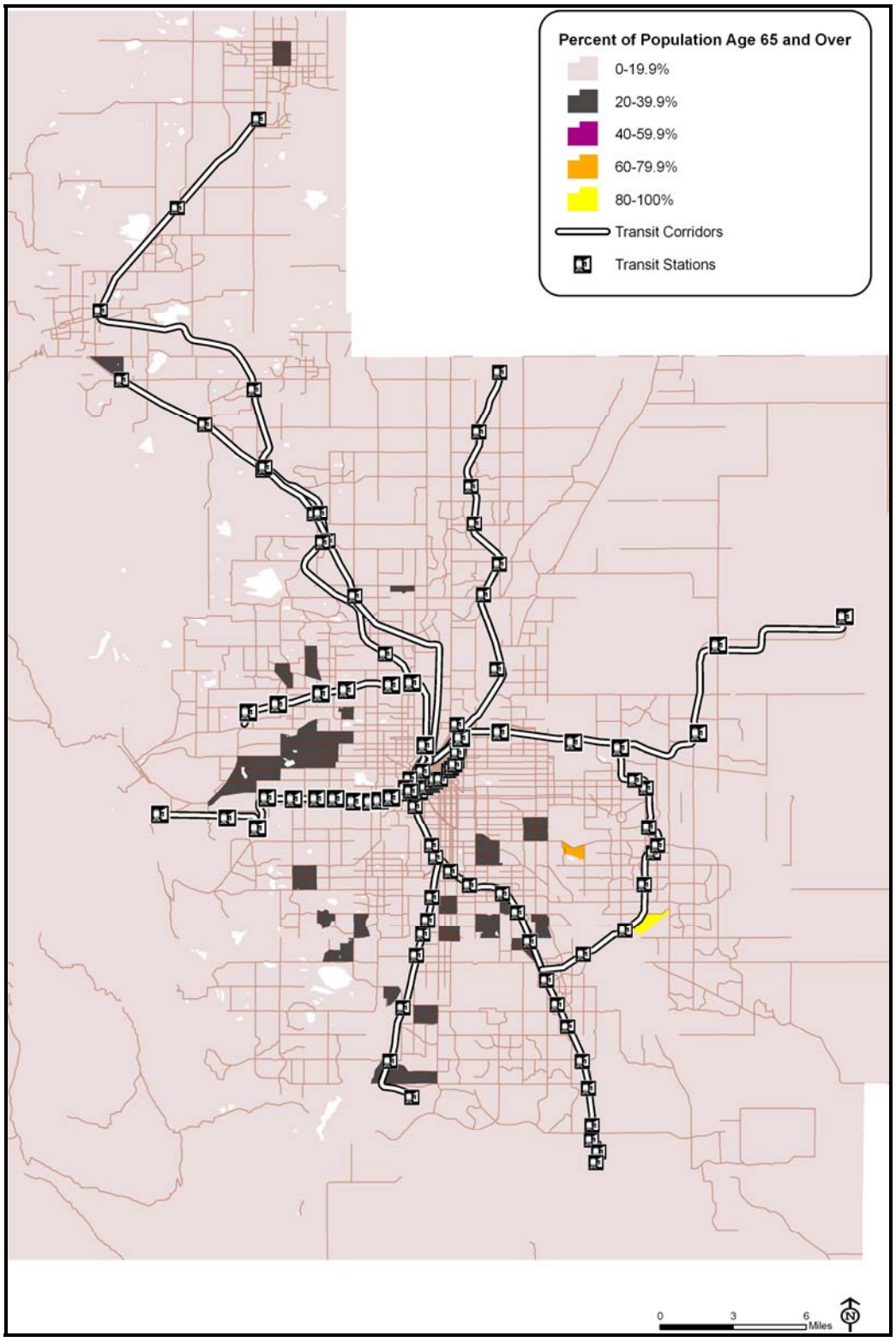


**Figure 28**
**Advanced Age Populations**



A separate but related trend involves the demographic shift of empty-nesters to lofts in the city. Loft-style housing offers a low-maintenance option, with access to retail, shopping and entertainment within walking distance. The development community has recognized this trend, and the demand for housing within the downtown area has grown substantially, particularly near Denver Union Station.

The FasTracks Plan will provide older adults with improved access to destinations such as health facilities and hospitals, cultural venues downtown and in suburban areas, churches and other key locations such as the airport. In addition, transit oriented development projects are planned around stations. These projects may include senior housing, which would provide direct accessibility to the stations. Housing, retail, and civic uses would be within walking distance of these stations, or may be accessed at other stations through travel by rail. To improve accessibility, many cities have been evaluating and/or adding Capital Improvement Projects to ensure that facilities such as sidewalks and trails connect to the stations. These facilities will assist the elderly and handicapped in accessing stations. (Source: Review of RTD FasTracks Plan, DRCOG, 2004).

### *b. Mobility*

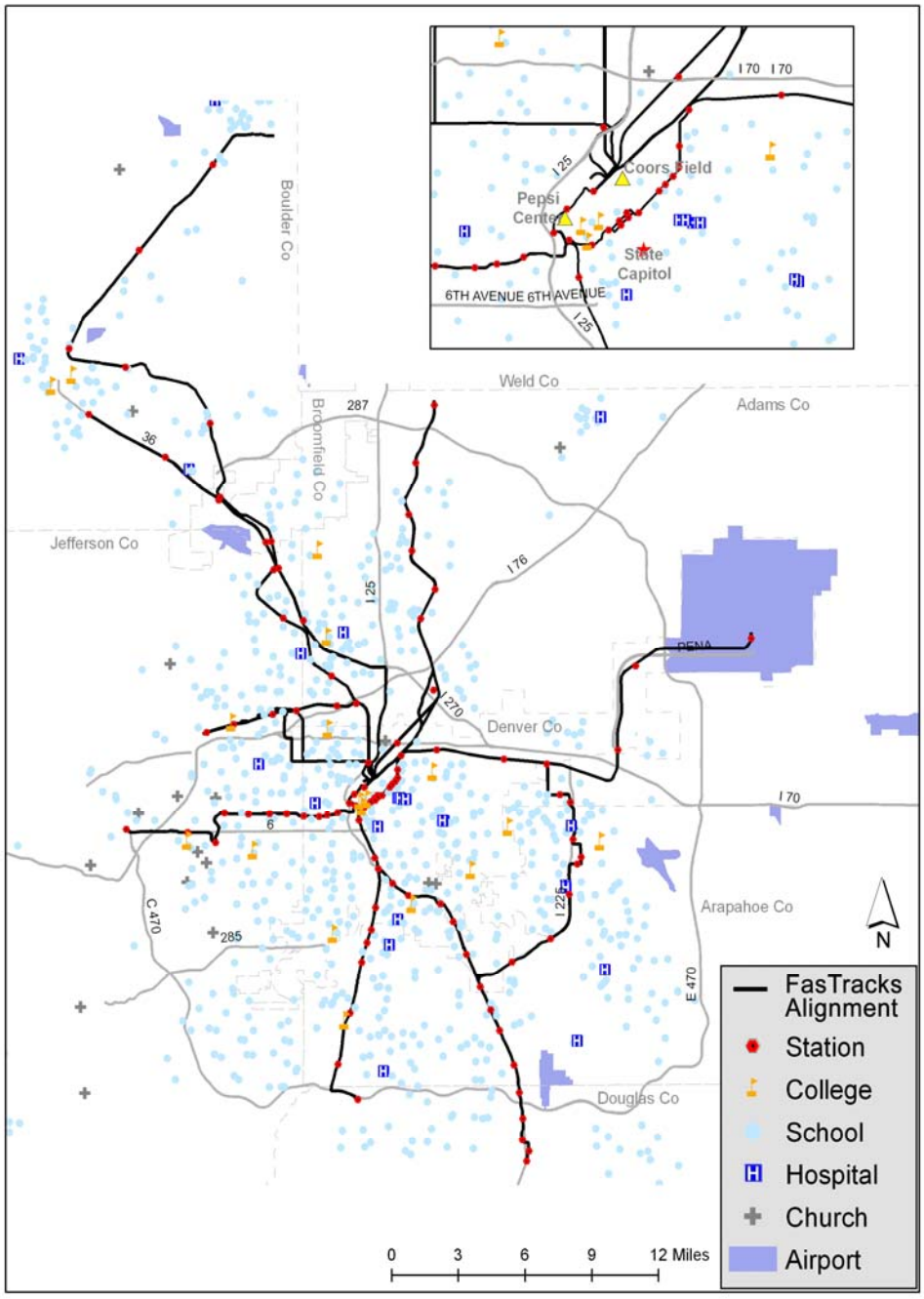
FasTracks will provide alternative transportation options at over 57 stations across the region. Residents need access both to and from transit through pedestrian and bicycle connections. Local jurisdictions have begun to access the circulation needs at each station. It is the responsibility of these jurisdictions to connect the stations into surrounding neighborhoods and activity centers through a system of bicycle and pedestrian pathways. Through this connectivity between transit and bicycle/pedestrian facilities, a multi-modal system will be created with less reliance on the automobile.

Travel patterns are expected to shift over time with the increased accessibility to transit options. The percentage of total trips on transit during the peak hour in the future will be higher with FasTracks than without FasTracks, respectively. The increase in transit trips will include both work and non-work trips. Residents will be able to access not only employment, but station amenities and services across the region. Neighborhoods will be better served and linked through transit connections and infrastructure. FasTracks will connect neighborhoods, and will link diverse neighborhoods through a series of stations and station amenities. Greater accessibility will be provided to major activity centers, such as schools, hospitals, recreation areas, churches, and employment centers.

### *c. Major Activity Centers*

**Figure 29** shows the FasTracks system relative to churches, schools (elementary and high school), colleges, airports and hospitals across the region. The graphic shows how FasTracks will serve community facilities that exist today. For examples, a number of the hospitals in the region, particularly in the City and County of Denver and surrounding municipalities, will be within 1 mile of transit in the future. The Fitzsimmons Complex and other health facilities along the I-225 Corridor will be served well by transit. In addition, a number of colleges are close to or directly served by FasTracks corridors, including the downtown Auraria campus and campuses along US 36. Denver International Airport will be served by transit along the East Corridor. This service will benefit the entire region, and due to the planned connectivity of lines within the system, populations across the region will be able to connect to the airport. Elementary and high schools are dispersed throughout the region, and therefore a comparison of access with and without transit is difficult at the regional level.

**Figure 29**
**Major Activity Centers**



## 6. Potential Mitigation and Recommendations

### *a. Corridor Mitigation, to be Implemented by RTD*

Each corridor should evaluate the most appropriate mitigation measures for low-income and/or minority populations disproportionately impacted in the respective corridors. Each corridor should discuss the proposed mitigation measures with RTD's real property specialists to ensure that any proposed measures do not conflict with the Uniform Relocation Act.

### *b. Programmatic Mitigation, to be Implemented by RTD*

Programmatic mitigation has been approved for those relocated due to construction of FasTracks. (FasTracks Environmental Policies and Procedures Volume II, April 2007) Displaced populations face a number of challenges in restructuring their lives. One such challenge is reestablishing their means of transportation and increasing their mobility and access to transit.

For those low-income or minority populations that will be relocated and/or directly impacted, RTD may provide:

- Annual transit passes for the first year of relocation
- Efforts to relocate the disproportionately affected persons to an area providing increased transit service
- Neighborhood Eco Passes (annual transit passes that allow free rides on all RTD services)

### *c. Recommendations, to be Implemented by Entities other than RTD*

- Local jurisdictions, in partnership with regional, statewide, and federal agencies, should consider policies to secure affordable housing at station areas to ensure that all segments of the population have access to transit.
- Local jurisdictions can program Capital Improvements for bicycle and pedestrian facilities to integrate the stations with surrounding neighborhoods. This will enhance the connectivity between the station areas and decrease reliance on the automobile for station access.
- The Denver Regional Council of Governments is working on a process to require metro communities to increase their density by 10 percent by 2030. This would help communities to consume less land, improve air quality, reduce water problems and improve transportation. RTD and local jurisdictions should support these goals.

# V. CONCLUSION

**Table 23** summarizes the current and future conditions described for each resource area. Generally, each of the resource areas is affected by the following trends:

- Population and employment growth
  - Related increases in housing demand, automobile traffic, mobility and access demands, and consumption of resources
- Stricter regulations governing air quality and water quality
- The difference in development patterns between the two future scenarios
  - Existing development trend of natural land conversion and rapid consumption for urban purposes
  - Potential for greater densification around station areas due to planned transit Oriented Development accompanying FasTracks
    - Subsequently less regional urbanization
- Population and employment control totals
  - The region will attract the same amount of people and jobs by 2030 regardless of FasTracks' implementation; only the distribution of population and employment will differ
- Emphasis on the automobile as the primary means of travel
  - FasTracks will increase the percentage of people taking transit during peak hours from 11 percent to over 22 percent on congested highways. Regardless of the increase in transit use and the potential shifts in land use patterns attributable to FasTracks, continued emphasis on the automobile as the primary means of travel will result in regional traffic, congestion, and automobile emissions.

**Table 23**
**Summary of Current and Future Conditions by Resource Area**

| Indicator | Current Conditions | Future Without FasTracks | FasTracks Impacts |
|---|---|---|---|
| **Economic** | | | |
| Employment | Employment growth | Employment growth of one percent each year until 2030 | Same growth trend plus additional 1,100 workers on FasTracks program plus multiplier effect for related and support services |
| Employment Areas | Vibrant employment areas | Employment areas with corresponding growth minus constraints of reduced mobility and increased congestion | Candidate pool becomes more diverse as accessibility increases; region more attractive for new businesses |
| Economic Base | Economic base of telecommunications, technology and tourism | Economic base remains the same but sector distribution may change | Same as Future without FasTracks |

**Table 23**
**Summary of Current and Future Conditions by Resource Area**

| Indicator | Current Conditions | Future Without FasTracks | FasTracks Impacts |
|---|---|---|---|
| Property Values | Increasing single family home values in past 3 years (over 6 percent) | Property value increases flatten over short term | Values improve due to attractiveness of the region |
| Jobs/housing ratio | Balanced jobs/ housing ratios with most counties having more jobs than housing | No substantial change in ratios | Changes will be influenced by local zoning decisions |
| Cost of Congestion | Rising | Continue rising | Slight decrease possible |
| **Land Use** | | | |
| Development | Ongoing development | Undeveloped areas fill in; more development occurs at existing rail corridor end-of-lines | Transit Oriented Development Opportunities at station areas |
| Natural land | Conversion of natural land covers to impervious surfaces | No change to existing trend of conversion | Less converted to development due to TOD's more dense development patterns |
| Residential and employment locations | Distribution becoming increasingly unbalanced | Population and employment growth | Number is similar to future without FasTracks; however distribution different<br>Increased population and employment numbers and densities near station areas |
| **Water Quality** | | | |
| Impacts due to Development (Impervious Surfaces) | Degraded water resources in agricultural areas<br>Platte River Basin water quality generally good, but threatened by increasing runoff channeled directly into water resources (from urbanization and rapid growth) | Increase in direct impacts to water resources due to increase in urbanized areas and impervious surfaces* | 280 acres of new impervious surface for parking facilities; 100 acres of new impervious surface for system components; TOD and densification at station areas contributing to less land conversion regionally |
| Impacts due to Pollutants | Nitrates and salinity in groundwater<br>Salinity and sediment in surface water | Increase in petroleum-based pollutants* | Similar to Future without FasTracks |
| **Increase will be less than proportional to the growth due to tighter regulations* | | | |
| **Air Quality** | | | |
| Mobile Source Air Toxics | 65 percent decrease compared to historic levels due to new regulations | Decline will continue due to increasingly-strict requirements | Slightly larger decline due to slight reduction in passenger traffic |
| Visibility | 54 percent of the time judged as "good to fair" | Growth in private automobile passenger traffic of 163.3 percent by 2030 | Reduction in passenger traffic |
| Greenhouse gases | 43 percent increase in Carbon Dioxide due | | |

**Table 23**
**Summary of Current and Future Conditions by Resource Area**

| Indicator | Current Conditions | Future Without FasTracks | FasTracks Impacts |
|---|---|---|---|
| | to increase in fossil fuel emissions<br>28 percent increase in methane due to increase in population and waste generation | | |
| Nitrogen deposition | 23 percent reduction expected by 2012 due to new regulations | | |
| **Energy** | | | |
| VMT and BTU | | Increasing due to increase in passenger traffic | Increase slightly less due to reduction in passenger traffic |
| **Wetlands** | | | |
| Wetland Quantity | Mitigations failing and principle of "no net loss" threatened | More than 50 acres of wetlands impacted due to large-scale and sprawling development | Up to 50 acres of wetlands impacted plus potential indirect impacts due to new construction and development around station areas |
| Wetland Quality | Decreasing due to increase in direct impacts resulting from increase in impervious surfaces | | No impact from new impervious surfaces due to drainage design; potential additional indirect impacts due to adjacent development |
| **Environmental Justice/Social** | | | |
| Demographics | Population and employment growth<br>Increase of 68 percent in Hispanic population from 1990 to 2000 Slowing housing market | Population increase of 38 percent by 2025<br>Minority populations becoming larger proportion of total population<br>No change in housing development pattern | No change<br>No change<br>Housing density will increase in station areas (creating a potential demand of up to 1600 additional units at each station area) |
| Mobility | 4.3 percent use transit to get to work<br>2.4 percent walk to work<br>0.7 percent bicycle to work | No potential for increase in use of alternate modes<br>Congestion worsening, making automobile access more time-consuming | Better access to more parts of the region created for low income, minority and elderly population groups |

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## Appendix A: Studies on the Impact of Public Transit on Property Values

| City | Year Study Published | Reference | Residential or Commercial | Summary of Results1 |
|---|---|---|---|---|
| Boston, MA | 1994 | Armstrong, Robert J. 1994. Impacts of Commuter Rail Service as Reflected in Single-Family Residential Property Values. Transportation Research Record, 1466 (1994): 88-97. | Residential | Increase in single-family residential property values of approximately 6.7 percent by virtue of being located within a community having a commuter rail station. At the regional level, there appears to be a significant impact on single-family residential property values resulting from accessibility provided by commuter rail service. |
| Boston, MA, Atlanta, GA, Chicago, IL, Portland, OR, and Washington DC | 2001 | Baum-Snow, Nathaniel and Matthew E. Kahn. 2001. The Effects of Public Transit to Expand Urban Rail Transit. Journal of Public Economics, Vol. 77, 2001, pp. 241-63. | Residential | Decrease from three to one kilometer distance from transit station increases rents by $19 per month, and housing values by $4,972. |
| Washington DC | 1996 | Benjamin, John D. and G. Stacy Sirmin. 1996. Mass Transportation, Apartment Rent and Property Values. The Journal of Real Estate Research, Vol. 12, No. 1 (1996). | Residential | Rents decrease by 2.4 percent to 2.6 percent for each one-tenth mile distance from a Metro station in Washington DC. |
| San Francisco, CA | 1994 | Bernick, M., R. Cervero, and V. Menotti. 1994. Comparison of Rents at Transit-Based Housing Projects in Northern California. Working Paper 624, University of California at Berkeley, Institute of Urban and Regional Development. | Residential | Rents at the BART housing projects are higher than those of nearby projects. |
| Atlanta, GA | 2001 | Bowes, David R. and Keith R. Ihlanfeldt. 2001. Identifying the Impacts of Rail Transit Stations on Property Values. Journal of Urban Economics, Vol. 50, 2001, pp. 1-25. | Residential | Properties between one and three miles of a transit station have a higher value than otherwise comparable properties located more than three miles away, but properties within 1/4 mile of a station are worth 19 percent less than homes beyond three miles. |
| San Francisco, CA | 1998 | Cambridge Systems. 1998. Economic Impact Analysis of Transit Investments: Guidebook for Practitioners. TRB Report 35, Transit Cooperative Research Program, Transportation Research Board | Commercial | Offices 0-1,300 feet from BART station see a property value increase of $0.13 per sq ft/month. Offices 1,300-2,000 feet from BART station see a property value increase of |

## Appendix A: Studies on the Impact of Public Transit on Property Values

| City | Year Study Published | Reference | Residential or Commercial | Summary of Results1 |
|---|---|---|---|---|
| | | (www.trb.org), 1998. | | $0.07 per sq ft/month. Retail spaces 0-500 feet from BART station see a property value increase of $0.07 per sq ft/month. |
| Santa Clara County, CA | 2002 | Cervero, Robert. 2002. Transit's Value Added: Effect of Light Commuter Rail Services on Commercial Land Values. Presented at TRB Annual Meeting, 2002. | Commercial | Substantial capitalization benefits to commercial-retail and office properties were found, on the order of 23 percent for a typical commercial parcel |
| Miami, FL, Toronto, Ontario (Canada) | 1999 | Diaz, Roderick B. 1999. Impacts of rail transit on property values. Commuter Rail/Rapid Transit Conference, Toronto, Ontario, American Public Transportation Association, 1999. | Residential | In Miami, home values near stations increased by up to 5 percent. In Toronto, nearby home value increases averaged $2,237. In general, proximity to rail increases accessibility, which is the primary factor in rising property values. |
| St. Louis, MO | 2004 | Garrett, Thomas A. Light Rail Transit in America: Policy Issues and Prospects for Economic Development. Federal Reserve Bank of St. Louis (www.stlouisfed.org), 2004. | Residential | Average home values increase $140 for every 10 feet closer to a MetroLink station. A home located 100 feet from the station has a price premium of $19,029 compared with the same house located 1,460 feet away. This represents a 32 percent increase. |
| Houston, TX | 1997 | Goodwin, Ronald E. and Carol A. Lewis. 1997. Land Value Assessment Near Bus Transit Facilities: A Case Study of Selected Transit Centers in Houston, Texas. Southwest Region University Transportation Center, Houston, Texas, 1997. | Residential | Housing values fell less near bus stops than they did in more distant locations. |
| Chicago, IL | 1997 | Gruen, Aaron. 1997. The Effect of CTA and MERTA Stations on Residential Property Values: Transit Stations Influence Residential Property Values. Report to the Regional Transportation Authority, June 1997. | Residential | More important than the presence of a transit station is the perception of the neighborhood desirability. But the proximity of transit does positively affect property values. The price of a single-family house located 1,000 feet from a station is 20 percent higher than a comparable |

## Appendix A: Studies on the Impact of Public Transit on Property Values

| City | Year Study Published | Reference | Residential or Commercial | Summary of Results1 |
|---|---|---|---|---|
| | | | | house located a mile away. Apartment properties located closer to train stations tend to realize higher rents and occupancy levels than comparable apartments less conveniently located. |
| Buffalo, NY | 2006 | Hess, Daniel Baldwin and Tangerine Maria Almeida. 2006. Impact of Proximity to Light Rail Rapid Transit on Station-Area Property Values in Buffalo. Paper 062198, Transportation Research Board 85th Annual Meeting (www.trb.org), 2006. | Residential | Every foot closer to a light rail station increases property values by $2.31 (using geographical straight line distance) and $0.99 (using network distance). A home located within one-quarter mile radius of a light rail station can earn a premium between $1,300 to $3,000 or 4 to 11 percent of the median assessed value. Other factors, such as number of bathrooms and size of parcel, are more influential than rail proximity in predicting property values. Proximity effects are positive in high income station areas, and negative in low-income station areas. |
| Portland, OR | 1996 | Knaap, Gerrit, Lewis Hopkins, and Arun Pant. 1996. Does Transportation Planning Matter? Explorations in the Effects of Planned Transportation Infrastructure on Real Estate Sales, Land Values, Building Permits, and Development Sequence. Lincoln Institute of Land Policy, Research Paper, 1996. | Residential | Values of parcels located within 1/2-mile of the line were found to decrease with distance from a station, but rise with distance from the rail line between stations. |
| Atlanta, GA | 1992 | Nelson, Arthur C. 1992. Effects of Elevated Heavy-Rail Transit Stations on House Prices with Respect to Neighborhood Income. Transportation Research Record 1359 (1992): 127-132. | Residential | In Atlanta's low value neighborhoods, a transit stop raises value. The reverse is also found, whereby in high value communities, installing a transit stop decreases site value by nearly the same amount. |
| Dallas, TX | 1999 | Weinstein, Bernard L. and Terry L. Clower. 1999. The Initial | Commercial | Proximity to stations appears to be an |

## Appendix A: Studies on the Impact of Public Transit on Property Values

| City | Year Study Published | Reference | Residential or Commercial | Summary of Results1 |
|---|---|---|---|---|
| | | Economic Impacts of the DART LRT System. Center for Economic Development and Research, University of North Texas, July 1999. | | economic advantage for most classes of real estate, especially Class A and C office buildings, and commercial strip retail outlets. Rents for Class A buildings near rail stations increased from an average $15.60/sq ft to $23/sq ft. Commercial strip retailers near stations gained a 64.8 percent improvement in rental rates. |

[1]*Summary of results as described in Financing Transit Systems Through Value Capture: An Annotated Bibliography by Jeffery J. Smith and Thomas A. Gihring, November 2006.*