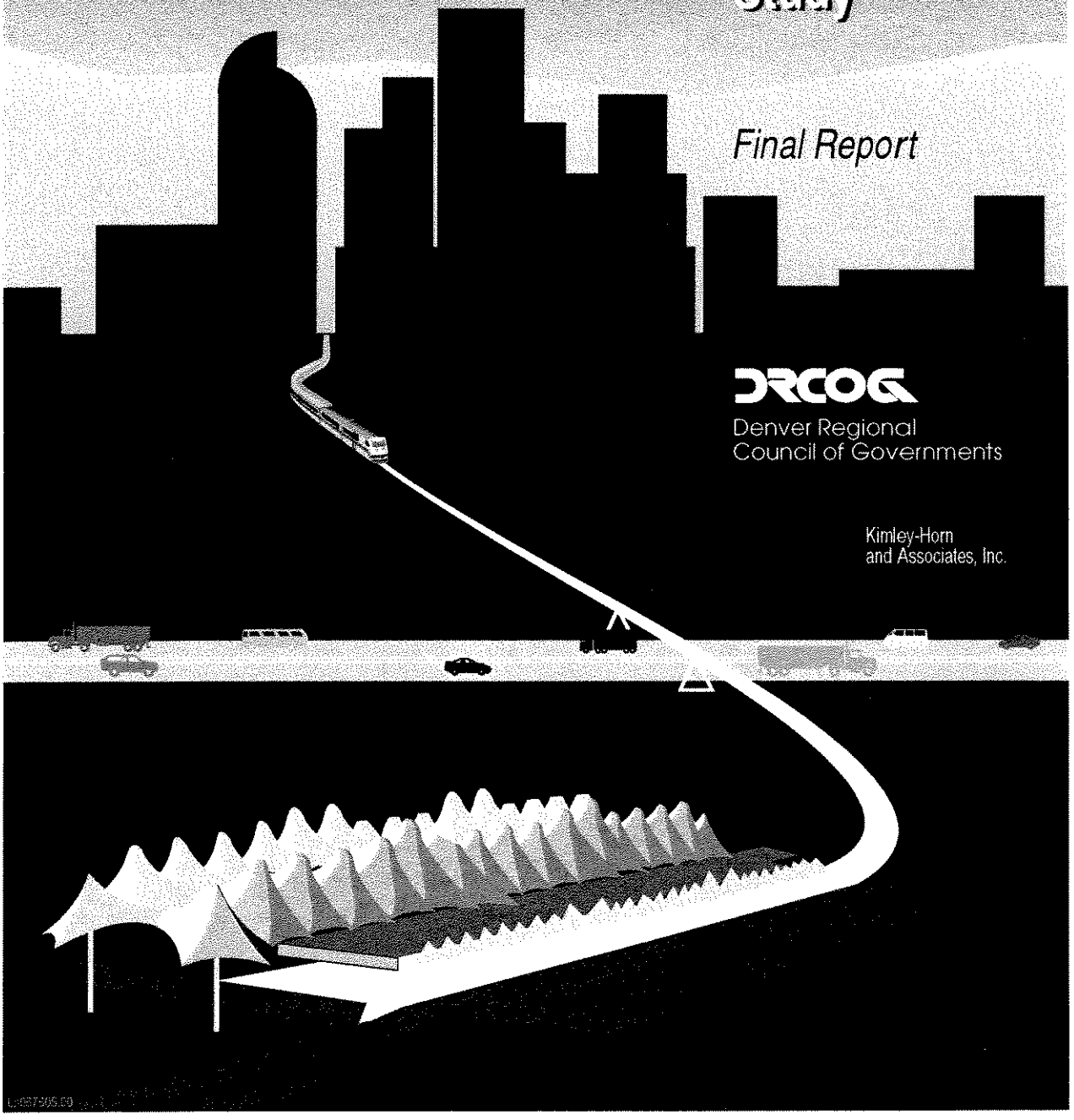
East Corridor Major Investment Study

Final Report



DRCOG
Denver Regional
Council of Governments

Kimley-Horn
and Associates, Inc.

EAST CORRIDOR MAJOR INVESTMENT STUDY
FINAL REPORT

July 1997

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EXECUTIVE SUMMARY

Introduction

The 2015 Interim Regional Transportation Plan (RTP) for the Denver metropolitan area, adopted by the Denver Regional Council of Governments (DRCOG) in 1993, designated the East Corridor, defined as the area between downtown Denver and Denver International Airport (DIA), as a Major Transportation Investment Study corridor. The East Corridor Major Investment Study (MIS) fulfills the intent of the 2015 RTP designation. **Specifically, the objective of this MIS is to identify the mix of transportation improvements that can be most effective in improving travel in the corridor within anticipated funding constraints while considering environmental and community impacts.** The East Corridor MIS also addresses the requirements for such studies as defined in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991.

The East Corridor Major Investment Study was one of three MIS projects conducted simultaneously in the Denver region over a two-year period. The transportation investment this study recommends will be advanced as a component of, or an amendment to, the region's fiscally constrained 2020 transportation plan. An initial budget target was established for major transportation investments in each of the three corridors, derived from estimates developed during the 2015 regional transportation plan process. The budget is for major capital expenditures and is considered above funds already programmed for maintenance, operations, and major rehabilitation or reconstruction of transportation facilities in the corridor. For the East Corridor, this initial budget was $390 million (in 1995 dollars). Recommendations were permitted to overrun the initial budget target somewhat in recognition of new funding initiatives and updated revenue calculations for year 2020.

Corridor Purpose and Need

The purpose and need for transportation improvements in the East Corridor were determined through the identification of key transportation and development issues and major travel markets using the Corridor. In addition, Regional Transportation Plan goals and policies relevant to the East Corridor were identified. These issues, travel markets, and regional goals and policies were used to assess the relative benefits of alternative transportation investments.

Evaluation Process

A multi-step evaluation process examined numerous transportation modes and alignment options in the Corridor. The process moved from a broad assessment of preliminary concepts to the detailed analysis of very specific alternatives. The specific steps included:

- pre-screening of a long list of mode and alignment options;
- screening of conceptual level alternatives;
- detailed evaluation of alternatives; and

- detailed evaluation of investment "packages" (based on combined elements from different alternatives).

The evaluation criteria and methodologies used in the East Corridor MIS were consistent with those used in the other two Major Investment Studies in the region.

Recommendations

The transportation investment recommended for the East Corridor includes commuter rail and light rail elements, a highway widening component, and transportation management elements. The major components of the recommended corridor investment are shown in **Figure ES-1**.

Commuter Rail and Light Rail Components

The rail concept proposed for the East Corridor includes the following elements:

- A single-track commuter rail line with passing track sections would be constructed between the Denver Union Terminal (DUT) in lower downtown Denver and DIA, generally following the Union Pacific Railroad alignment to east of Chambers Rd., where it turns north through the I-70/Peña Blvd. interchange, and then runs along the east side of Peña Blvd. into the south end of the DIA terminal. Total distance: approximately 23 miles.

- The Central Corridor light rail transit (LRT) line would be extended one mile north to intersect the commuter rail line.

- Intervening stations would be established at the LRT/commuter rail interface (40th St./40th Ave.), at Stapleton, and in the Gateway area. An additional light rail station would be constructed at 33rd and Downing.

- New and existing Regional Transportation District (RTD) bus service would be oriented to feed commuter rail as appropriate.

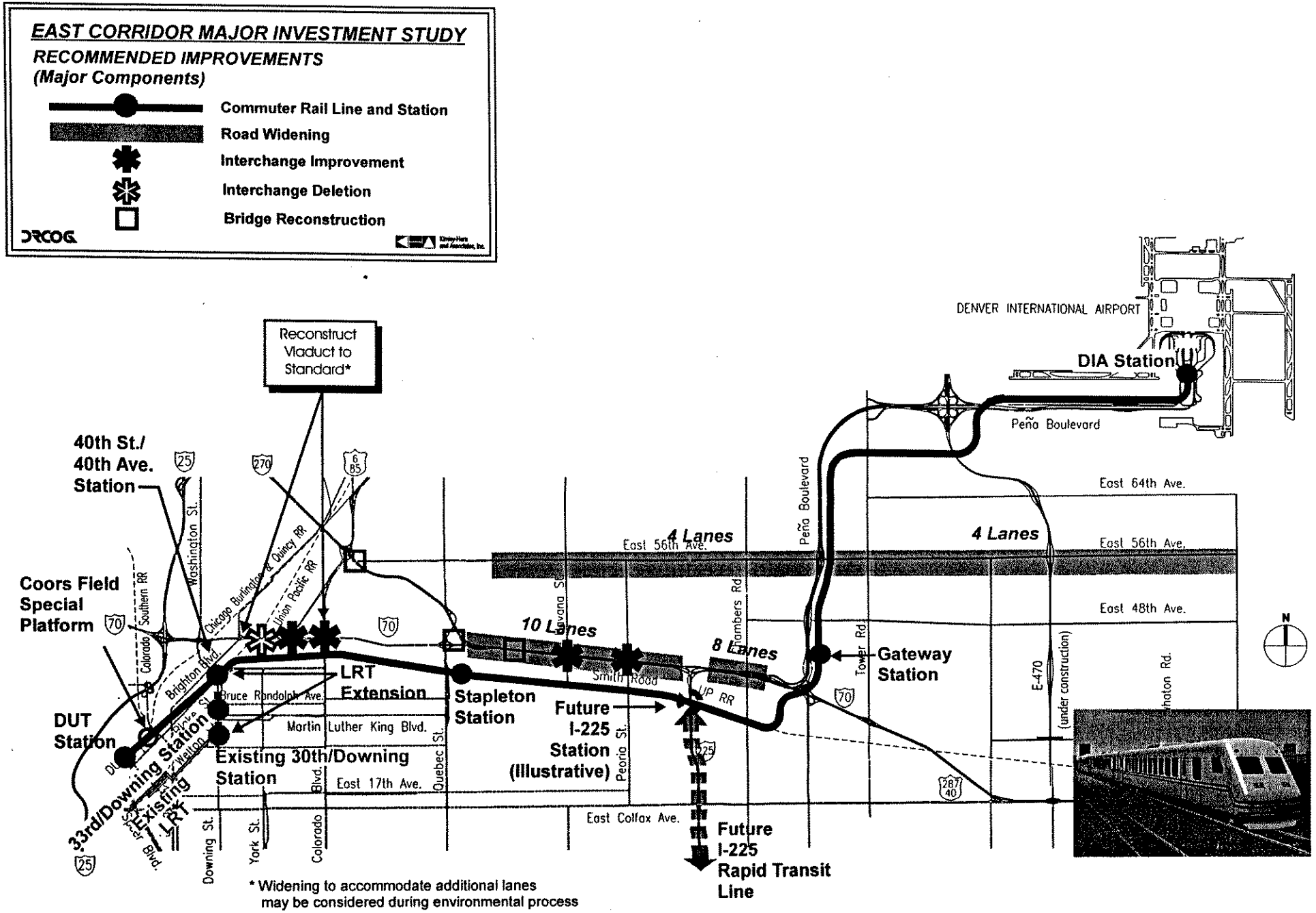
- Vehicle technology recommended for use on the commuter rail line is a self-propelled diesel car operating singly or in short trains (called diesel multiple-units or DMUs). The specific DMU technology envisioned is large vehicles with performance characteristics superior to conventional diesel push/pull technology.

Freeway Components

Highway capacity is increased on the most highly congested segment of the East Corridor, between I-270 and I-225, in the recommended investment package. I-70 would be reconstructed and widened to five through lanes in each direction in this "inner beltway" segment. I-70 also would be widened in each direction between I-225 and Peña Blvd. to transition this additional laneage.

The I-70 viaduct between Brighton Blvd. and Colorado Blvd. would be reconstructed. The East Corridor MIS Policy Level Advisory Committee recommended that viaduct reconstruction only include widening to bring the inside and outside

Figure ES-1


EAST CORRIDOR MAJOR INVESTMENT STUDY
RECOMMENDED IMPROVEMENTS
(Major Components)
Commuter Rail Line and Station
Road Widening
Interchange Improvement
Interchange Deletion
Bridge Reconstruction
DRCOG
Reconstruct Viaduct to Standard*
DENVER INTERNATIONAL AIRPORT
DIA Station
Peña Boulevard
40th St./ 40th Ave. Station
Coors Field Special Platform
DUT Station
33rd/Downing Station
Existing LRT
Existing 30th/Downing Station
LRT Extension
Stapleton Station
Future I-225 Station (Illustrative)
Future I-225 Rapid Transit Line
Gateway Station
4 Lanes
10 Lanes
8 Lanes
East 64th Ave.
East 56th Ave.
East 48th Ave.
East 17th Ave.
East Colfax Ave.
Martin Luther King Blvd.
Bruce Randolph Ave.
Smith Road
Tower Rd.
E-470 (under construction)
Chambers Rd.
Peoria St.
Quebec St.
Colorado Blvd.
Downing St.
York St.
Washington St.
Brighton Blvd.
Colorado
Southern RR
Chicago Burlington & Quincy RR
Union Pacific RR
UP RR
Havana St.
Peña Boulevard
N
* Widening to accommodate additional lanes may be considered during environmental process

shoulders to standard, but it was noted that, during the Environmental Impact Statement (EIS) process, widening to accommodate additional lanes may be considered. The EIS process would incorporate meaningful, proactive public participation. The cost of viaduct reconstruction was not counted against the corridor budget.

The highway improvements recommended are in addition to East Corridor improvements that are already approved (and thus not included in the Corridor budget), including reconstructing and widening of the freeway between Washington and Brighton, reconstructing the I-70/I-225 interchange, and replacing the Broadway viaduct with a four-lane underpass.

Transportation Management Components

The Transportation Management elements of this package are a collection of smaller, mutually supportive projects intended to improve operations and modify or reduce the demand for travel in the East Corridor. The Transportation Management elements are divided into two major types of improvements: *supply-related* or Transportation System Management (TSM) projects, and *demand-related* or Transportation Demand Management (TDM) strategies. TSM components in the East Corridor include arterial improvements such as the widening of 56th Ave. from Quebec to DIA, new bus service in eastern Aurora and Denver, Intelligent Transportation Systems infrastructure, and bicycle/pedestrian facility improvements. TDM recommendations include various actions designed to increase use of the rail investment and reduce congestion.

Costs

The recommended corridor investment is estimated to have a total capital cost of approximately $441 million, comprised of:

- $316 million for the commuter rail line;
- $14 million for the light rail extension on Downing;
- $38 million for widening of I-70; and
- $73 million for transportation management improvements.

The corridor investment's annual operating and maintenance costs are estimated at $31.7 million.

The recommended single-track commuter rail with the light rail extension would be about $100 million less expensive than double-track commuter rail with a light rail extension and about $190 million less than double-track light rail along the same alignment.

The City and County of Denver has been pursuing commuter rail to DIA as a public-private partnership for several years. Denver staff members have indicated that commuter rail can be delivered at an "on-budget" capital cost not to exceed $220 million through cost-savings due to private-sector design-build efforts, or with other revenues controlled by Denver. It is recommended that the implementing agency work with Denver to realize this proposal.

Benefits

The investment would provide a number of transportation benefits to the East Corridor in year 2020, including:

- reducing regional vehicle miles of travel by 41,000 miles per weekday;
- reducing regional weekday person hours of delay by almost 9%;
- increasing weekday transit ridership in the Corridor by nearly 9,000 persons.

Of the estimated 108,800 weekday users of the major elements in the recommended corridor investment, about 95,900 would be highway users and the remaining 12,900 would be rail users.

The largest increase in person-carrying capacity would be between I-270 and I-225, where commuter rail and four additional general traffic lanes would accommodate a total of 6,365 more persons per hour in each direction. Projected weekday use of the additional capacity provided in that segment by peak-hour, peak-direction travelers would exceed 90 percent.

Weekday morning and afternoon peak-hour travel times between the Denver central business district (CBD) and DIA would improve for all modes. The greatest improvement would be for transit riders traveling between the CBD and DIA during the afternoon peak hour, who would save about 17 minutes of travel time with the recommended corridor investment. This time savings, coupled with the increased reliability of commuter rail (which is not influenced by highway congestion), would provide a substantial benefit for one key travel market in the East Corridor.

The segment of I-70 between Brighton Blvd. and Colorado Blvd. would experience severe congestion during peak periods under the proposed six through-lane cross-section.

Impacts

The evaluation process also assessed potential impacts to communities and natural resources of transportation improvements in the Corridor.

Community Impacts

The recommended corridor investment is estimated to require acquisitions of a minimum of two residences and two businesses; mitigation of neighborhood concerns could result in additional residential displacements. While more than 300 homes would remain within 300 feet of an improved transportation facility in the Corridor, most of these are already within 300 feet of an existing transportation facility. All of the acquisitions and homes remaining within 300 feet of an improved transportation facility are within predominantly low-income or minority neighborhoods, since such neighborhoods ring downtown Denver to the east and northeast.

Natural Resources Impacts

There are no significant anticipated impacts to natural resources as a result of the recommended corridor investment.

1 MIS BACKGROUND

1.1 Study Purpose/Relationship to Regional Transportation Plan and Regional Planning Process

The 2015 Interim Regional Transportation Plan (RTP) for the Denver metropolitan area, adopted by the Denver Regional Council of Governments (DRCOG) in 1993, designated the East Corridor, defined as the area between downtown Denver and Denver International Airport (DIA), as a Major Transportation Investment Study corridor. The East Corridor Major Investment Study (MIS) fulfills the intent of the 2015 RTP designation. Specifically, the objective of this MIS is to identify the mix of transportation improvements that can be most effective in improving travel in the corridor within anticipated funding constraints while considering environmental and community impacts. The East Corridor MIS also addresses the requirements for such studies as defined in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991.

The primary purpose of a Major Investment Study is to provide a rigorous decision-making process for determining transportation investments. As such, this East Corridor MIS includes information that is sufficient to measure and evaluate a range of investment options. It included careful consideration of a full range of mobility alternatives, quantitative and qualitative measures to assess and evaluate alternatives against a baseline, and an open process including community input for determining the preferred investment. Transportation alternatives were examined in corridor- and system-wide contexts and analyzed for their impacts on air quality. Costs were estimated for each alternative and related to a financially constrained corridor budget. The transportation investment this study recommends will be included in the region's fiscally constrained 2020 transportation plan to the extent that funding is available.

1.2 ISTEA Requirements/the MIS Process

The ISTEA metropolitan planning rules and regulations governing the conduct of Major Investment Studies outline a number of characteristics that an MIS must include. The East Corridor MIS was conducted with those characteristics in mind:

- It included a cooperative and collaborative process comprised of major participants in the regional planning process, with the aim of coming to a regional consensus on the range of alternatives that were studied and the factors used to evaluate them.
- It included an evaluation of the effectiveness and cost-effectiveness of alternatives in attaining regional transportation goals and policies.
- The MIS considered the capital and operating costs of alternatives studied, along with a variety of other key factors such as mobility benefits; community and environmental effects; safety; and land use and economic development.

- The East Corridor MIS used a proactive public involvement process that provided a variety of opportunities for the public and various interest groups in the Corridor to participate in the deliberative process.

- Finally, the East Corridor MIS has provided documentation of the consideration given to all transportation alternatives developed and their impacts. This report, and the reports and appendices that support it, are the result of that documentation process.

The ISTEA metropolitan planning rules outline two options for linking Major Investment Studies to the National Environmental Policy Act (NEPA) documentation process. The option chosen for the East Corridor MIS requires that the results of this study be documented in a final report that serves as input to the subsequent formal NEPA process and documentation. The MIS has resulted in the identification of a recommended corridor investment, and the process has developed sufficient information to support elimination of modal alternatives and avoid re-examination in the NEPA process. This MIS adhered to the principles of the NEPA process, including the consideration of alternatives and their environmental effects, interagency coordination, a systematic interdisciplinary approach, and public involvement, but does not include NEPA documentation.

1.3 Coordinated MIS Approach within the Region

The East Corridor Major Investment Study was one of three MIS projects conducted simultaneously in the Denver region over a two-year period. In 1994, the region's major planning agencies -- the Denver Regional Council of Governments (DRCOG), the Regional Transportation District (RTD), and the Colorado Department of Transportation (CDOT) agreed to initiate three Major Investment Studies in three critical corridors in the Denver region:

- the East Corridor (along I-70 from Downtown to DIA);

- the West Corridor (along U.S. 6/ W. Colfax from Downtown to Golden); and

- the Southeast Corridor (along I-25 from Downtown to Lincoln Ave., including I-225 to Parker Rd.).

The three agencies agreed to coordinate these Major Investment Studies and share certain management responsibilities for them. Overall direction was provided by the DRCOG Transportation Committee, comprised of policy board members and executive staff from CDOT, RTD, and DRCOG. Detailed coordination was addressed by the MIS Coordinating Committee, which included project management staff from the three agencies and their consultant teams. The levels of analysis and other key details for the three MIS projects were developed based on this coordination structure between the three sponsoring agencies, and from input by

relevant federal, state and local government agencies.

Briefings on the three Major Investment Studies were given to regional bodies on a regular basis, including:

- DRCOG Board of Directors;
- DRCOG Transportation Committee;
- DRCOG Transportation Policy Committee;
- DRCOG Transportation Advisory Committee;
- DRCOG Regional Review Team;
- DRCOG Regional Planning Advisory Committee;
- RTD Board of Directors; and
- Colorado Transportation Commission.

The three agencies and their consultants developed a "Guidance Manual" that established common criteria, methodologies, and procedures for conducting the technical analysis of the transportation alternatives developed in the three corridors. This common analysis process was aimed at giving regional decisionmakers consistent information as to benefits, costs, and impacts of the various transportation alternatives developed in the three corridors.

A budget was established for major transportation investments in each of the three corridors, derived from estimates developed during the 2015 regional transportation plan process. The budget is for major capital expenditures and is considered above funds already programmed for maintenance, operations, and major rehabilitation or reconstruction of transportation facilities in the corridor. For the East Corridor, this budget was initially established at $390 million (in 1995 dollars). In recognition of new funding initiatives and revenue forecasts for 2020, moderate overrun of the budget target was considered permissible.

1.4 Coordination with Denver's Air Train Proposal

The City and County of Denver has been pursuing a commuter rail concept to Denver International Airport (called the "Air Train") with private sector participation. Air Train project participants were consulted at several key points throughout the East Corridor MIS process and attended technical and policy meetings for the MIS. Specific details regarding commuter rail alignment options, operating plans, and cost estimates were discussed with Air Train interests.

2 CORRIDOR STUDY PROCESS

2.1 Overview of Tasks/Technical Work Process

The work program for the East Corridor Major Investment Study was patterned after federal regulatory requirements contained in the metropolitan planning rules as adapted to meet the specific characteristics of the Corridor and the region. The key elements of the East Corridor MIS work program included:

- Task 1: Project Management.
- Task 2: Public and Agency Involvement Process
- Task 3: Project Initiation, including:
  - Preparation of a project Guidance Manual to develop consistent evaluation criteria and processes;
  - Preparation of a comprehensive summary of past studies within the corridor;
  - Collection of data on existing and future conditions in the corridor; and
  - Preparation of a "Purpose and Need Report" to provide a definition of the transportation problems and conditions in the corridor.
- Task 4: Conceptual Level Screening, including
  - Definition of conceptual alternatives;
  - Evaluation of conceptual alternatives using several key screening criteria (consistency with regional goals and policies; capital cost and affordability; mobility levels; environmental impacts; and community impacts); and
  - Preparation of a screening evaluation technical report, resulting in a "short list" of alternatives recommended for more detailed evaluation.
- Task 5: Detailed Level Evaluation, including:
  - Definition of detailed alternatives; and
  - Evaluation of detailed alternatives (using detailed evaluation criteria including effectiveness/benefits; costs/affordability; cost-effectiveness; and environmental and community impacts).

Each major step in the MIS process was documented in a technical report. These reports served as important milestones in the process, and allowed different audiences and advisory groups to comment on specific details. The full series of technical reports, available from DRCOG, includes:

- *Technical Report No. 1: Project Management Plan*
- *Technical Report No. 2: Guidance Manual* (developed by all three MIS teams)
- *Technical Report No. 3: Purpose and Need*

- *Technical Report No. 4: Definition of Conceptual Level Alternatives*
- *Technical Report No. 5: Evaluation of Conceptual Level Alternatives*
- *Technical Report No. 6: Description of Detailed Level Alternatives*
- *Technical Report No. 7: Evaluation of Alternatives*
- *Technical Report No. 8: Recommendations*
- *Technical Report No. 9: Recommended Corridor Investment Plans, Profiles, and Cost Sheets*
- *East Corridor MIS Public Involvement Record*

2.2 Policy-Level Advisory Committee

A key element of the East Corridor MIS evaluation and decision process was the ongoing involvement of elected and appointed officials from throughout the Corridor. The formal structure for the participation of those individuals was the study's Policy-Level Advisory Committee. These individuals provided ongoing review and comment on all aspects of the study, particularly at key project milestones. This committee was composed of representatives of local, regional, and state government policy bodies (including some quasi-governmental bodies). Bodies represented included:

- the City and County of Denver;
- the City of Aurora;
- the City of Commerce City;
- Adams County;
- the City of Arvada;
- the Colorado Transportation Commission;
- the Regional Transportation District; and
- the E-470 Authority.

2.3 Committee of Technical Staff

Another key Corridor committee was composed of federal, state, regional and local government staff who had an interest or stake in the project, in addition to other agency representatives as appropriate. This Committee was asked to review all technical reports developed for the study. This Committee included representatives from:

- the City and County of Denver;
- the City of Aurora;
- the City of Commerce City;
- Adams County;
- the City of Arvada;
- Denver Regional Council of Governments ;
- Colorado Department of Transportation;
- Colorado Department of Health and the Environment;
- Regional Transportation District;
- Regional Air Quality Council;
- Federal Highway Administration;
- Federal Transit Administration;
- Federal Aviation Administration;
- Union Pacific Railway;
- Public Utilities Commission;

- E-470 Authority
- Denver Union Terminal; and
- the Downtown Denver Partnership.

2.4 Public Involvement Process

The East Corridor Major Investment Study relied on an intensive and comprehensive public involvement process. The public involvement process was designed to meet federal planning regulations in that it was proactive, early and continuing, complete, timely, broad in its outreach, and responsive. Community involvement techniques used throughout the course of the study included:

- a series of general public meetings at key points in the study process;
- specific issue meetings with government officials and community leaders to discuss issues of concern to those individuals;
- meetings with community and neighborhood groups in the Corridor throughout the project, but especially during key decision points (groups were informed that Spanish-speaking members of the MIS project team would be made available at their request);
- an ongoing media relations effort;
- an MIS newsletter for all three corridors, with special inserts highlighting East Corridor activities; and
- the development and maintenance of a comprehensive mailing list of interested citizens and organizations throughout the corridor.

Complete details of all public involvement activities, meetings, and briefings have been assembled in a *Public Involvement Record.*

3 CORRIDOR PURPOSE AND NEED SUMMARY

3.1 Corridor Description/Overview

On February 28, 1995, the new Denver International Airport (DIA) began operations, replacing Stapleton International Airport as the Denver metropolitan area's major air terminal. Before DIA opened, traffic on Interstate 70 was at or near capacity on many of its segments. For example, in 1988, the segment of I-70 between I-270 and I-225 carried an average of 116,800 vehicles per day; by 1993, it was used by 138,600 vehicles per day. Two weeks after the opening of DIA, traffic on this same segment of I-70 had increased to more than 170,000 vehicles per day, an increase of 24%.

The opening of DIA, with its associated traffic patterns, focused attention on the need to improve mobility throughout the I-70 corridor from downtown Denver to DIA. The area shown in **Figure 3-1** and loosely defined by East Colfax Ave. to the south, 56th Ave./Peña Blvd. to the north, I-25 and the Denver Central Business District to the west, and DIA to the east is the East Corridor Study area. The East Corridor stretches about 25 miles and includes portions of three cities (Denver, Aurora, and Commerce City) and two counties (Denver and Adams).

I-70 fulfills a number of important transportation functions for the region:

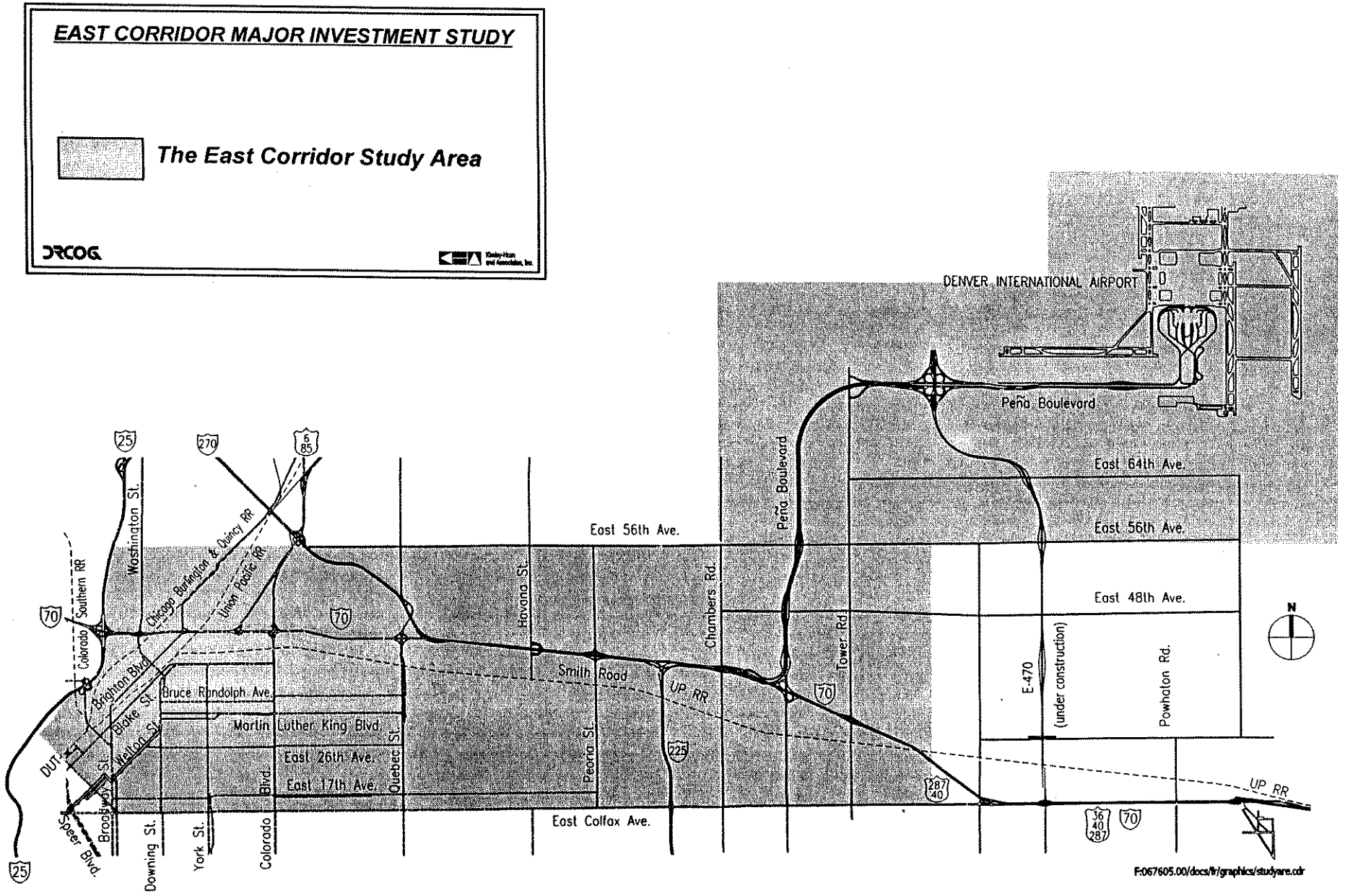
- it serves both interstate and intrastate travel;
- as the only east-west freeway on the east side of metro Denver, it provides important regional access to downtown Denver from the eastern part of the metropolitan area;
- it is the most crucial link for people and goods between central Denver and DIA;
- it is a critical link of an "inner beltway" that includes I-270 and I-225;
- it provides vital access to adjacent employment areas and intermodal freight facilities; and
- it serves key development and redevelopment areas, including the Stapleton Airport site and the Gateway development.

Travel demand through the East Corridor, including demand associated with DIA, has resulted in congestion, especially during peak periods (which are growing longer every year). This increased traffic growth, coupled with the age of I-70 (more than 30 years), suggests that planning for a comprehensive set of long-range transportation improvements in the Corridor would be appropriate.

3.2 Land Use and Development Issues

Several existing and projected East Corridor land use and demographic dynamics were considered as transportation alternatives were developed, including:

Figure 3-1


EAST CORRIDOR MAJOR INVESTMENT STUDY
The East Corridor Study Area
DRCOG
DENVER INTERNATIONAL AIRPORT
Peña Boulevard
East 64th Ave.
East 56th Ave.
East 48th Ave.
East 26th Ave.
East 17th Ave.
East Colfax Ave.
Martin Luther King Blvd.
Bruce Randolph Ave.
Smith Road
Washington St.
Colorado Blvd.
Brighton Blvd.
Blake St.
Walton St.
Broadway St.
Speer Blvd.
Downing St.
York St.
Quebec St.
Havana St.
Peoria St.
Chambers Rd.
Tower Rd.
E-470
(under construction)
Powhaton Rd.
Southern RR
Chicago, Burlington & Quincy RR
Union Pacific RR
UP RR
DUT
N
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- **Residential population in the East Corridor is projected to increase by 23% between 1995 and 2015.** In addition, there are generally higher residential densities projected for the Corridor in the future, primarily the result of the multi-family residential areas proposed for the Gateway and Stapleton developments. Higher densities generally require more concentrated transportation improvements, including transit.

- **Employment in the East Corridor is projected to increase by 40% over the next twenty years, with employment expected to increase faster in the non-CBD areas of the Corridor.** Overall employment growth will be focused on the Denver CBD, the Stapleton Redevelopment area, along Peña Blvd. at the Airport Gateway, and at DIA. These concentrations of employment growth could impact the shape and course of future transportation improvements, especially directly along I-70. In addition, future employment in the Corridor is forecast to be almost twice the Corridor's projected population, indicating that the Corridor is a major regional destination for employment purposes.

- **Several East Corridor neighborhoods have high minority populations and are subject to special considerations whenever major transportation improvement decisions are being contemplated.** Environmental justice addresses the potential for minority or low-income neighborhoods to be disproportionately impacted by transportation improvements. Areas with high concentrations of minority population include the Swansea, Globeville, Elyria, Cole, Whittier, Clayton, Skyland, North Park Hill, Northeast Park Hill, and Montbello neighborhoods of Denver.

- **Several areas in the East Corridor have relatively high proportions of traditionally transit-dependent residents.** The low-income population in the Corridor is concentrated in the northeast Denver area (including south Montbello) and northwest Aurora. Downtown Denver and the Five Points/North Capitol Hill, City Park West, and Park Hill areas have high concentrations of elderly residents. Areas with households averaging less than one car per household include downtown Denver and the Five Points, North Capitol Hill, and City Park West neighborhoods. These findings suggest one element of the study would be to assure convenient and affordable public transit service in those neighborhoods, linking those residents particularly to newly developing job opportunities.

- **New development in the Corridor will need improved access.** Residential and commercial growth projected for the Corridor (primarily associated with the new developments proposed for the Stapleton and Gateway areas), growth in air cargo activity in and around Denver International Airport (DIA), and future parks and open space plans (including the conversion of the Rocky Mountain Arsenal into a wildlife refuge) will all

cause the need for improved access in the East Corridor.

- **Outside of I-70, the only significant continuous through roadways in the Corridor are East Colfax Ave. and 56th Avenue (which was built through the Stapleton site after the East Corridor MIS was started).** Major physical barriers -- including Stapleton, Lowry Air Force Base, Fitzsimons Medical Center, and the Rocky Mountain Arsenal -- have prevented the construction of more through roads in the Corridor. Redevelopment of those areas will provide some improved access, but their specific development plans prepared to date call for either no through access (such as at the Rocky Mountain Arsenal) or limited through access in those areas.

- **Several existing sites in the East Corridor pose potential barriers to transportation improvements.** Major barriers include interstate highways, residential areas, railroads, the Rocky Mountain Arsenal/Wildlife Refuge site, and the former Stapleton Airport. Crossing or penetrating any of these barriers with major transportation projects could result in higher costs and community or environmental impacts that must be taken into account as new transportation corridors are planned.

3.3 Transportation Issues

Several major transportation related issues exist in the East Corridor that must be considered when developing transportation alternatives:

- **The East Corridor is being called upon to accommodate the ever-increasing levels of passenger and goods movement with a deteriorating infrastructure.** I-70, the primary highway facility in the Corridor, was constructed in the early 1960s. Its bridges and viaducts originally were designed to serve a useful life of 30 years. Now past that designed life span, the facility is experiencing deterioration and faces the need for major rehabilitation or reconstruction within the time horizon of this study. Several portions of the freeway's elevated structures are classified as structurally deficient or functionally obsolete and are scheduled for replacement or rehabilitation. However, the portion of the viaduct segment between Brighton Blvd. and Colorado Blvd. is rated as "structurally deficient," but neither its replacement nor rehabilitation is funded as of yet.

- **Travel volumes on I-70 are far in excess of those anticipated when the facility was designed and built.** When I-70 opened in 1964, the Denver metropolitan area had a population of approximately one million. By 1995, that population had grown to two million. That regional population increase resulted in substantially higher travel volumes on I-70 than was expected when it was first constructed. Moreover, the construction of new "linking" freeways in the area (including I-270 and I-225) has funneled additional

traffic onto critical segments of I-70. Traffic on the most heavily used section of I-70 (from I-270 to I-225) increased from 138,800 vehicles on an average weekday in 1993 to more than 170,000 on one day in May 1995 (just after the opening of Denver International Airport) -- an increase of more than 20% in just two years.

- **I-70 operates at Level of Service "F" during peak hours in both directions.** Peak periods on the freeway have increased to 2-3 hours in the mornings and up to four hours in the afternoons. Moreover, traffic is almost equally split between eastbound and westbound vehicles at all hours of the day. During peak periods, traffic volumes on I-70 between I-270 and I-225 are in the Level of Service (LOS) E range, where even minor disruptions can cause significant delays. In addition, the segment between I-25 and I-270 operates close to capacity in the LOS E to F range during peak periods. The substandard side clearances and interchange geometry of this segment (much of which is elevated) contributes to those problems. Even with existing and committed roadway improvements, most major arteries in the Corridor (and not just freeways) will experience significant amounts of congestion by the year 2015.

- **I-70 through the East Corridor experiences accidents at a rate 40% higher than the state average for urban freeways.** The segments between I-25 and Brighton and between I-225 and Chambers have accident rates almost twice the state average, though some of those rates can be attributed to highway construction. The segment between Brighton and Colorado experiences an accident rate 60% above the statewide average, mainly due to substandard geometry and ramps.

- **Truck traffic comprises a significant portion of all traffic in the Corridor.** The northwest corner of the Corridor contains the highest concentration of truck terminals in the state. In addition, truck traffic comprises up to 14% of total daily traffic on I-70 throughout the Corridor, increasing to almost 20% of all traffic east of Peoria.

- **An average of 5,300 commercial vehicles enter and exit DIA each day.** While that total is a relatively insignificant percentage of total East Corridor traffic, it comprises roughly 10% of all traffic on Peña Blvd. between DIA and I-70.

- **There is a sparsity of transit service and park-and-ride lots in the eastern reaches of the Corridor.** The Regional Transportation District (RTD) provides good local bus service in the densely populated southern and southwestern parts of the Corridor, but relatively little service in less populated areas. Outside of skyRide service to DIA, only one traditional express route operates in the Corridor on I-70, and it experiences an average weekday ridership lower than most routes in the Corridor. The most-used transit route in the Corridor is the local and limited service provided along East Colfax Ave. Only three park-and-

ride lots are located in the East Corridor east of the 30th/Downing LRT station.

- **The UP railroad corridor stretches the length of the study area and presents an opportunity for enhancement as a multi-modal transportation facility.** Approximately 83 trains operate every day through the East Corridor, but most of those operations occur generally north-south on the western edge of the Corridor. The Union Pacific operates eight trains per day through the heart of the East Corridor, from Denver Union Terminal paralleling I-70 along Smith Rd. to the eastern edge of the Corridor, and this could double or more when the operations of the merged Union Pacific/ Southern Pacific are revised. UP has a major intermodal yard northeast of downtown between Downing and York. At least 17 grade crossings exist on the UP railroad between the CBD and Airport Blvd. The amount of freight train traffic in this corridor now and in the future could act as a barrier to transportation improvements.

In summary, the following issues from those identified above were considered most important for recommending the Corridor Investment:

- The lack of significant continuous east-west roadways (and other transportation facilities) in the Corridor;
- Current traffic congestion during peak periods on several segments of I-70;
- An accident rate on I-70 higher than the state average for freeways;
- Substantial heavy truck traffic;
- An aging and deteriorating infrastructure;
- Relatively high proportions of transit-dependent residents in certain areas of the Corridor; and
- Large quantities of vacant land with the potential for substantial residential and business growth.

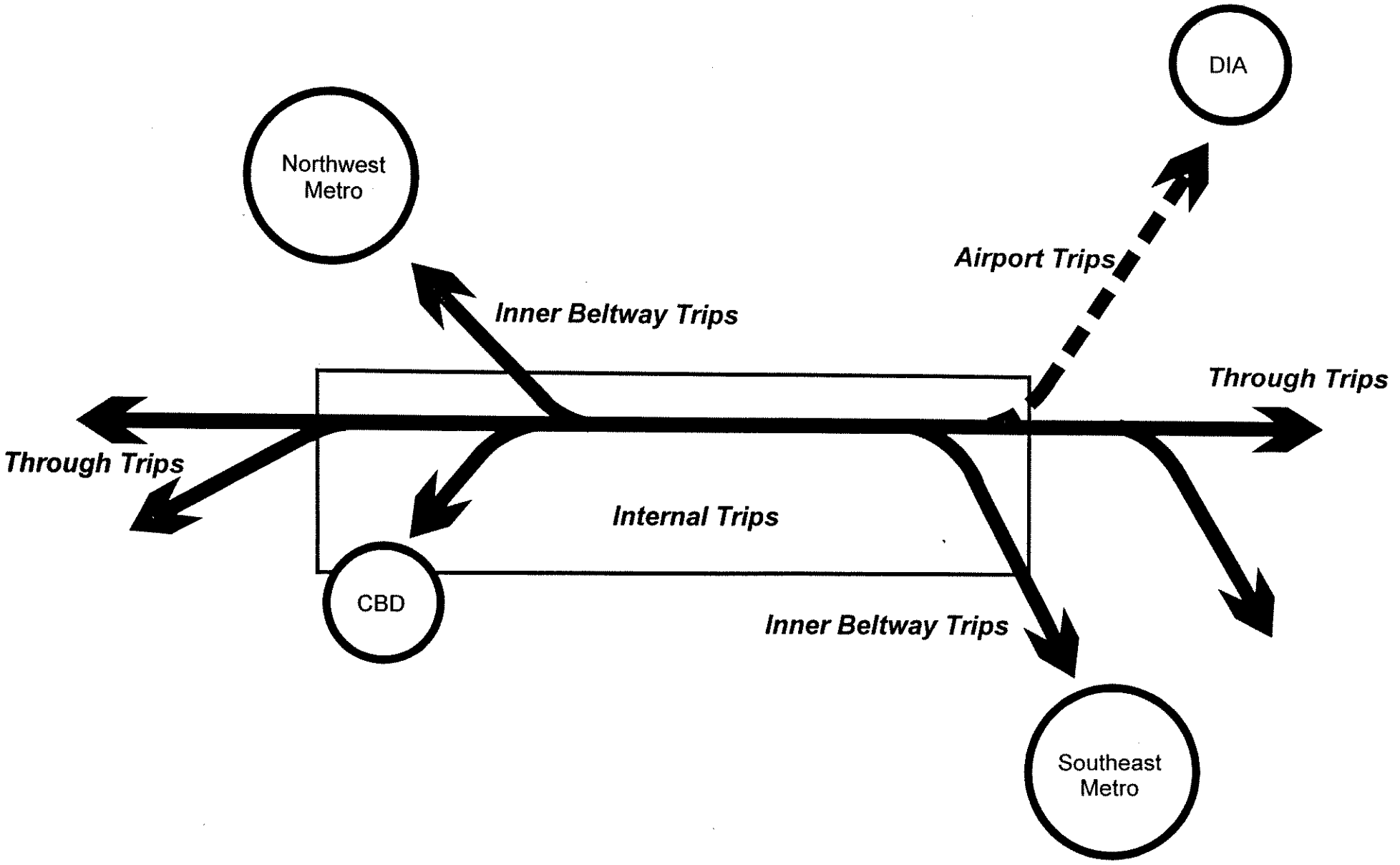
3.4 Major Travel Markets

Interstate 70 was designed to be a part of the National Defense Highway System with the express purpose of facilitating interstate travel. I-70 is the major east-west highway through Colorado. As such, the accommodation of regional trips was a secondary purpose of the facility. The accommodation of local trips was not a significant original purpose of the interstate system.

A travel demand analysis conducted for the East Corridor MIS at the former location of the airport tunnels on I-70 showed several significant current and future travel markets, (as shown in **Figure 3-2**) including:

- **"Inner beltway"** trips between the southeastern and northwestern portions of the metropolitan area, primarily using I-70 as a link between I-225 and I-270;
- **"Airport"** trips, including to and from downtown Denver and the mountain areas west of Denver;

Figure 3-2
Major Travel Markets in the East Corridor



- **"Through"** trips from east or southeast of the Corridor to areas west of the Corridor; and

- **"Internal"** trips that use I-70 to travel between East Corridor neighborhoods and employment centers (such as downtown).

The travel demand analysis shows that only 11% of all traffic through the I-70 segment between I-270 and I-225 is currently generated by Denver International Airport; that percentage is forecast to grow to 16% by 2015.

3.5 Relevant Regional Policies and Goals

The transportation improvement projects recommended in this East Corridor MIS were developed within a regional context, based on goals and policies to ensure coordination with the regional transportation planning process. These goals and policies are derived from the 2015 *Interim Regional Transportation Plan* (RTP, adopted by DRCOG in October 1993) and are designed to encourage the

> "... development of a multimodal and intermodal transportation system with strong ties to the development planning process. They recognize that regional solutions must be found to regional transportation and air quality problems; and that the region's development growth, transportation and air quality problems must be jointly addressed."

The RTP's goals and policies reflect a need to:

- Reduce congestion and provide access through multimodal solutions;

- Support economic development through the provision of high-priority facilities; and

- Preserve and enhance the natural and built environment.

Because the RTP's goals and policies address the broad array of activities required of a *regional* long-range transportation planning process, not every one is specifically applicable to a corridor-focused MIS. The regional multimodal goals and policies from the 2015 RTP considered most applicable in this study are:

RTP Goal: "Provide Accessibility and Mobility for People and Goods"

Related RTP Policies Appropriate to East Corridor MIS:

- "Increase the regional system's capability to efficiently move people and goods."
- "Implement rapid transit to reduce vehicle miles traveled and the need for additional roadway capacity."
- "Design the rapid transit system to have a significant time savings over highway travel during the peak period."

RTP Goal: "Enhance the Quality of Life and Minimize Adverse Impact on the Natural Environment. Integrate Planning for Regional Development, Transportation, and Air Quality."

Related RTP Policies Appropriate to East Corridor MIS:

- "Reduce mobile source emissions and conform to state implementation plans for attaining and maintaining the national ambient air quality standards. Incorporate transportation control measures adopted in state implementation plans."
- "Emphasize the use of alternative modes rather than adding significant roadway capacity within the areas at immediate risk of exceeding the national ambient air quality standards."
- "Provide multimodal options and multiple access points to major destinations such as regional shopping centers, business districts, and airports."
- "Minimize energy consumption and reduce reliance on petroleum energy sources."

RTP Goal: "Implement the Adopted Regional Transportation Plan (RTP)"

Related RTP Policies Appropriate to East Corridor MIS:

- "Make major transportation corridor operations more efficient by implementing Intelligent Transportation System strategies."
- "Design safe and efficient transportation facilities."

3.6 Conclusions: Purpose and Need for Major Transportation Investments in the East Corridor

In the years ahead, as population and employment growth continue in the East Corridor and major new developments (including those at Stapleton and Gateway) are implemented, conditions on I-70 will worsen: increasing congestion for longer periods of the day; slow travel speeds; large amounts of truck traffic; spillover traffic to local arterials; an increased number of accidents and incident-related congestion; and environmental consequences (especially degradation of air quality). All the while, the existing freeway infrastructure will continue to age and deteriorate.

Clearly, there is a need to develop and evaluate a wide range of alternatives for passenger and goods movement to address the East Corridor's growing transportation problems. The need for transportation improvements in the East Corridor is specified in the adopted RTP, which calls for implementation of projects that increase needed person-carrying capacity. This MIS is necessary to identify appropriate modal investments, and to ensure that federal funds can potentially be used for funding these projects.

4 TRANSPORTATION ALTERNATIVES EVALUATION PROCESS

4.1 Overview of Evaluation Process

The recommended major transportation investment for the East Corridor is the product of a multi-step evaluation process that examined numerous transportation modes and alignments. In essence, the process moved from broad assessment of preliminary concepts to detailed analysis of very specific alternatives. Input was sought from the public, the Policy Level Advisory Committee, and the Committee of Technical Staff at each major step of the process.

The major steps of the evaluation process are illustrated in **Figure 4-1.** They included:

- *Pre-Screening,* through which mode and alignment options from the "long list" were eliminated if they failed to meet specific criteria regarding regional policies and goals, affordability, community and natural resource impacts, and mode feasibility as a proven operating technology.

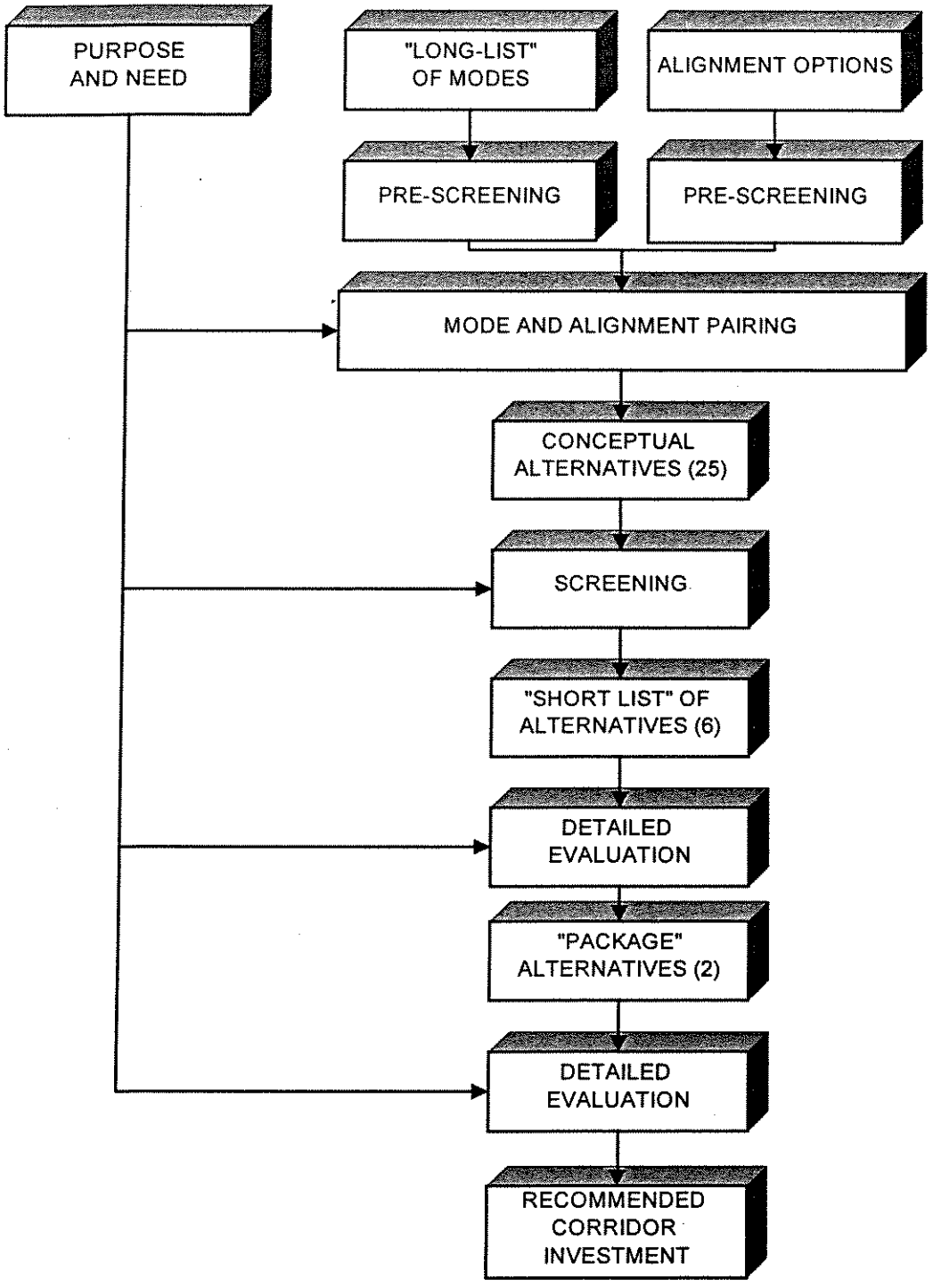
- *Mode and Alignment Pairing,* which combined the candidate modes and alignments that passed the pre-screening process and eliminated potential alternatives where specific technologies were inappropriate within specific corridors.

- *Screening*, which evaluated conceptual alternatives based on their potential to achieve objectives for regional goals and policies, affordability, mobility levels, likely environmental impacts, and likely community impacts. These criteria were similar to those used in the "pass/fail" approach in the pre-screening process, but focused on the alternatives' relative success in achieving objectives. The screening process resulted in six discrete alternatives advanced for detailed evaluation.

- *Detailed Evaluation of Alternatives*, which entailed defining six alternatives in sufficient detail to estimate their capital and operating/maintenance costs, forecast their mobility benefits, assess their impacts to corridor communities and natural resources, and evaluate their ability to address corridor travel markets, issues, and regional policies and goals. This detailed evaluation process resulted in two combinations or packages of potential transportation improvements, based upon slightly modified components of several of the six detailed level alternatives.

- *Detailed Evaluation of Packages*, which applied the same level of detail and analysis as the previous step to the two packages of improvements, leading to a recommended investment for the East Corridor.

Figure 4-1: East Corridor MIS Evaluation Process



4.2 Pre-Screening of Mode and Alignment Options

Mode Pre-Screening

A long list of mode options for the East Corridor was developed from input received from neighborhood and community groups, the Committee of Technical Staff, and the Policy Level Advisory Committee. The mode options were developed at a conceptual level of detail, and were then subjected to a pass/fail test according to five criteria. Failure to meet all of the criteria eliminated the mode from further evaluation. The results of the pre-screening process are presented in **Table 4-1.**

Alignment Pre-Screening

Several potential alignments were examined in the East Corridor, including freeways, freight railways, and arterials. Recommendations on which alignments to advance for conceptual level evaluation were based on input from neighborhood and community groups, the Committee of Technical Staff, and the Policy Level Advisory Committee. The alignment options that were reviewed are indicated in **Figure 4-2,** and the pre-screening results are presented in **Table 4-2.**

Mode and Alignment Pairing

The pre-screening process yielded seven modes and five alignments for further evaluation. To develop a list of conceptual alternatives, the pre-screened modes and alignments were combined and assessed as to whether they were feasible options for further evaluation. This assessment was based on the original pre-screening criteria, and whether or not individual modes and technologies were appropriate within specific alignments. The results of the mode and alignment combining and review process are presented in **Table 4-3.**

4.3 Conceptual Level Alternatives and Findings

The pre-screening process resulted in 25 conceptual level alternatives, each consisting of a specific mode and alignment. Each conceptual level alternative was assessed based on criteria similar to those used in the pre-screening process, but with findings based on each alternative's *relative* success in achieving stated objectives, including:

- consistency with regional goals and policies;
- capital cost and affordability within corridor budget;
- ability to improve mobility in the corridor;
- minimizing environmental impacts; and
- minimizing community impacts.

The key objective of the screening process was to select the best alignment within each modal group so that a smaller set of diverse modal alternatives could be advanced to the detailed evaluation stage. In addition, the screening process compared similar modal options, such as busways and bus/HOV lanes, to determine which option had the best potential performance.

Table 4-1
Pre-Screening of Mode Options

Advanced for Further Analysis:	Consistent with Regional Goals and Policies?	Affordable?	Resolvable Environmental Impacts?	Resolvable Community Impacts?	Proven in Revenue Service?
Additional General Traffic Lanes: *Widen Arterial* *Widen Freeway*	Yes	Yes	Yes	Yes	N/A
Commercial Vehicle Lanes: *Arterial* *Freeway*	Yes	Yes	Yes	Yes	N/A
Bus/HOV Lanes: *Arterial* *Freeway*	Yes	Yes	Yes	Yes	Yes
Busway: *Arterial* *Freeway*	Yes	Yes	Yes	Yes	Yes
Light Rail Transit: *Exclusive ROW* *Semi-Exclusive ROW*	Yes	Yes	Yes	Yes	Yes
Commuter Rail Transit	Yes	Yes	Yes	Yes	Yes
Not Advanced for Further Analysis:					
Additional General Traffic Lanes: *Double-Deck Existing Freeway*	No	No	No	No	N/A
Light Rail Transit: *Shared Right-of-Way*	No	Yes	Yes	No	Yes
New Roadway	No	No	No	No	N/A
Heavy Rail	Yes	No	Yes	Yes	Yes
Monorail Transit	Yes	No	No	No	No
People-Mover	Yes	No	No	No	No
Personal Rapid Transit	Yes	No	No	No	No
High-Speed Rail Transit	Yes	No	No	No	Yes
Guided Busway	Yes	No	No	No	No

Figure 4-2

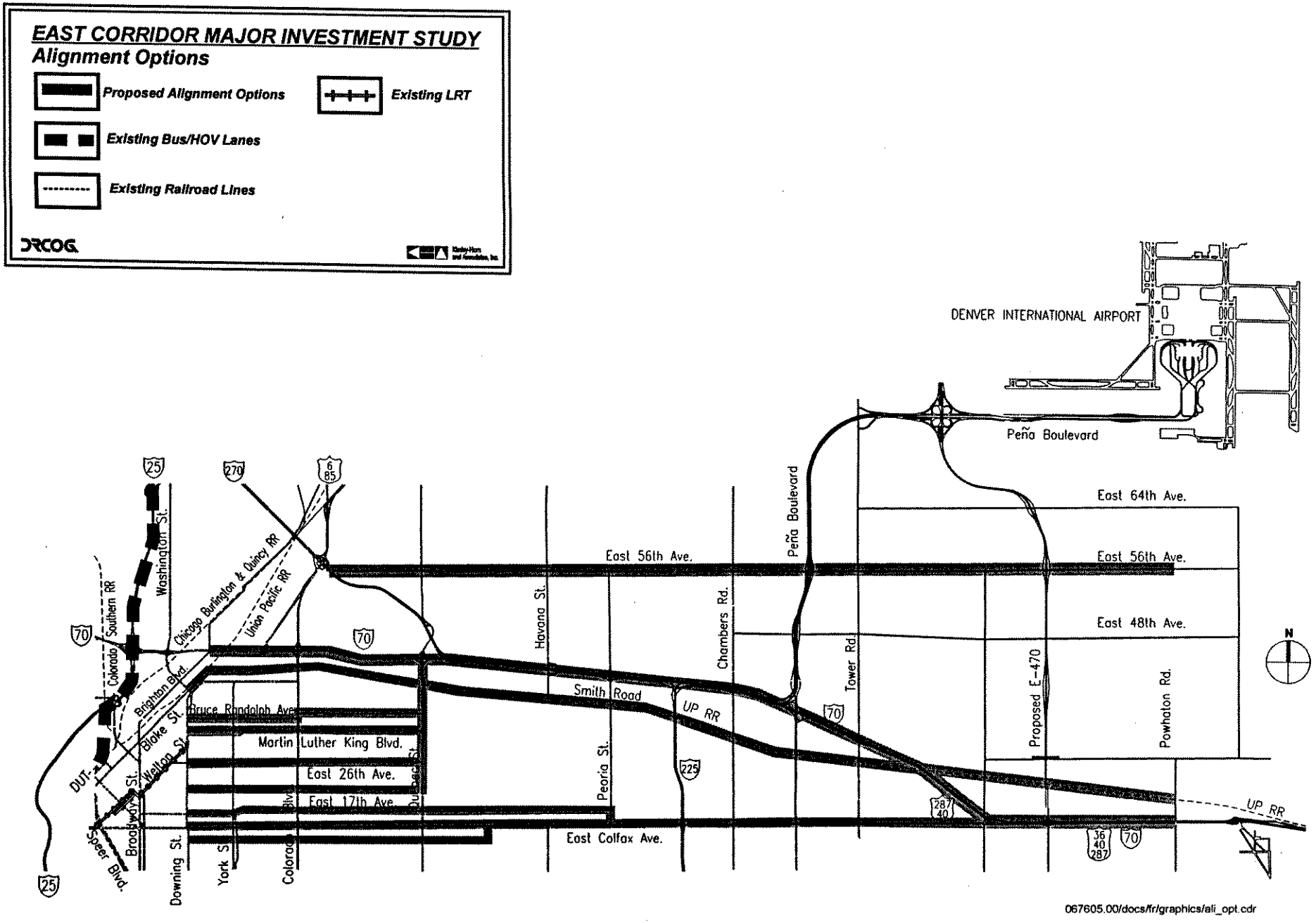

EAST CORRIDOR MAJOR INVESTMENT STUDY
Alignment Options
Proposed Alignment Options
Existing LRT
Existing Bus/HOV Lanes
Existing Railroad Lines
DRCOG
DENVER INTERNATIONAL AIRPORT
Peña Boulevard
East 64th Ave.
East 56th Ave.
East 48th Ave.
East 26th Ave.
East 17th Ave.
East Colfax Ave.
Martin Luther King Blvd.
Bruce Randolph Ave.
Smith Road
UP RR
Proposed E-470
Powhaton Rd.
Tower Rd.
Chambers Rd.
Havana St.
Peoria St.
Quebec St.
Colorado Blvd.
York St.
Downing St.
Broadway
Speer Blvd.
DUT
Welton St.
Blake St.
Brighton Blvd.
Colorado Southern RR
Washington St.
Chicago Burlington & Quincy RR
Union Pacific RR
N
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Table 4-2
Pre-Screening Summary of Alignment Options

Alignment	Advance to Further Analysis?	Comments
I-70	Yes	Only E-W freeway option in Corridor
E. 56th Ave.	Yes	Only option north of I-70
UPRR/Smith Rd.	Yes	Only E-W railroad line in Corridor
Through Streets		
Bruce Randolph/35th	No	
MLK Blvd.	Yes, as prototype	Best residential street opportunity in Corridor
E. 26th Ave.	No	
E. 23rd Ave.	No	
E. 17th/18th Ave.	No	
E. Colfax	Yes, as prototype	Best commercial street opportunity in Corridor
E. 13th/14th Ave.	No	

Table 4-3
Pre-Screening Mode and Alignment Pairing

Modes	Freeway	Arterial			
	I-70	56th Ave	UP/Smith Rd.	MLK Blvd.	E. Colfax
Additional General Traffic Lanes	*Retain Option*	*Retain Option*	*Retain Option*	*Retain Option*	*Retain Option*
Commercial Vehicle Lanes	*Retain Option*	*Retain Option*	*Retain Option*	*Delete Option* (Not appropriate)	*Delete Option* (Not appropriate)
Bus/HOV Lanes	*Retain Option*	*Retain Option*	*Retain Option*	*Retain Option*	*Retain Option*
Busway	*Retain Option*	*Retain Option*	*Retain Option*	*Delete Option* Very high community impact (elevated); high capital cost; not affordable.	*Delete Option* Very high community impact (elevated); high capital cost; not affordable.
Exclusive Light Rail Transit	*Retain Option*	*Retain Option*	*Retain Option*	*Delete Option* Very high community impact (elevated); high capital cost; not affordable	*Delete Option* Very high community impact (elevated); high capital cost; not affordable
Semi-Exclusive Light Rail Transit	*Delete Option* (Not appropriate)	*Retain Option*	*Retain Option*	*Retain Option*	*Retain Option*
Commuter Rail	*Delete Option* (Not appropriate)	*Retain Option*	*Retain Option*	*Delete Option* (Not appropriate)	*Delete Option* (Not appropriate)

The results of the screening process, summarized in **Table 4-4**, recommended four different mode and alignment alternatives be advanced to evaluation at a detailed level. "No Capacity Increase" and "Transportation Management" alternatives were added to the list to represent base-case and low-cost options, respectively.

4.4 Detailed Level Alternatives and Findings

4.4.1 Alternatives

The six alternatives which emerged from the screening process were defined in sufficient detail to estimate their capital and operating costs, forecast their mobility benefits, assess their impacts to corridor communities and natural resources, and evaluate their ability to address corridor travel markets, issues, and regional policies and goals. Brief summaries of each alternative are provided below.

- *Alternative 1: No Capacity Increase*

  This alternative did not add capacity to the I-70 corridor beyond those projects already programmed, which include reconstructing and widening I-70 between Washington and Brighton, reconstructing the I-225/I-70 interchange, and replacing the Broadway viaduct with a four-lane underpass. To assess the cost of rebuilding other portions of I-70 towards higher design standards, a Re-Build component was defined as a non-capacity increasing increment to the No-Build component. Re-Build components included "essential" reconstruction items (based on CDOT structure deficiency ratings), and "additional" items. Reconstructing the I-70 viaduct between Brighton and Colorado was identified as an "essential" Rebuild project. As part of that project, the geometrically deficient York/Josephine interchange would be eliminated to improve safety, provide better interchange spacing on I-70, and avoid the community impacts that would result from rebuilding the York/Josephine interchange to standard. Essential Re-Build components were considered to be implemented outside the Corridor budget. **Figure 4-3** shows the improvements called for under the Re-Build component.

- *Alternative 2: Transportation Management*

  This alternative was designed to provide a level of travel benefits and transportation options in the corridor at substantially lower costs than the "build" alternatives. It included new park and ride lots, new and enhanced bus services, minor improvements to I-70 interchanges, arterial improvements, Intelligent Transportation System (ITS) components, bicycle and pedestrian facilities, and Transportation Demand Management strategies. The transportation infrastructure for Stapleton redevelopment was assumed to have been constructed in this alternative. **Figure 4-4** shows the improvements proposed under the Transportation Management alternative.

Table 4-4
Summary of Conceptual Level Alternative Screening Process Findings

Mode	Potential Alignments	Comments	Recommendation
Additional General Traffic Lanes	I-70, E.56th Ave., UPRR/Smith Rd., MLK Blvd., E. Colfax Ave.	Widening I-70 produces the greatest mobility benefits. The community impacts of widening local streets are likely to be greater than those associated with widening I-70.	General Traffic Lanes on I-70
Commercial Vehicle Lanes	I-70, East 56th Ave., UPRR/Smith Rd.	Use of an exclusive commercial vehicle lane would be low and would not contribute significantly to overall corridor mobility.	No further consideration
Bus/HOV Lanes	I-70, East 56th Ave., UPRR/Smith Rd., MLK Blvd., East Colfax Ave.	I-70 would provide the highest speeds, consistent with the region's goals for rapid transit. The community impacts of widening local streets to accommodate Bus/HOV lanes are likely to be greater than those associated with widening I-70.	Bus/HOV lanes on I-70
Busway	I-70, East 56th Ave., UPRR/Smith Rd.	The UPRR/Smith Rd. corridor would be the best performer, but there would be difficulties with integrating bus and freight rail operations and conflicts with UPRR's future right-of-way needs within the Corridor. Also, anticipated bus service provision in the Corridor would be far below the capacity of a busway.	No further consideration
Exclusive Light Rail Transit	I-70, East 56th Ave., UPRR/Smith Rd.	The community impacts of adding exclusive LRT along UPRR/Smith Rd. are expected to be less than the impacts along I-70 or E. 56th Ave. The UPRR/Smith Rd. alignment would have similar ridership to I-70, and 50% more than E. 56th Ave.	Exclusive LRT on UPRR/Smith Rd.
Semi-Exclusive Light Rail Transit	East 56th Ave., UPRR/Smith Rd., MLK Blvd., East Colfax Ave.	Semi-exclusive LRT is not capable of providing rapid transit, would have moderate to high traffic and parking impacts, and has more community impacts than exclusive LRT. Ridership gains for semi-exclusive LRT are small. Public opposition to LRT on any neighborhood streets was substantial.	No further consideration
Commuter Rail	East 56th Ave., UPRR/Smith Rd.	The UPRR/Smith Rd. alignment would have the higher expected ridership and fewer community impacts than the E. 56th alignment.	Commuter Rail on UPRR/Smith Rd.

Figure 4-3

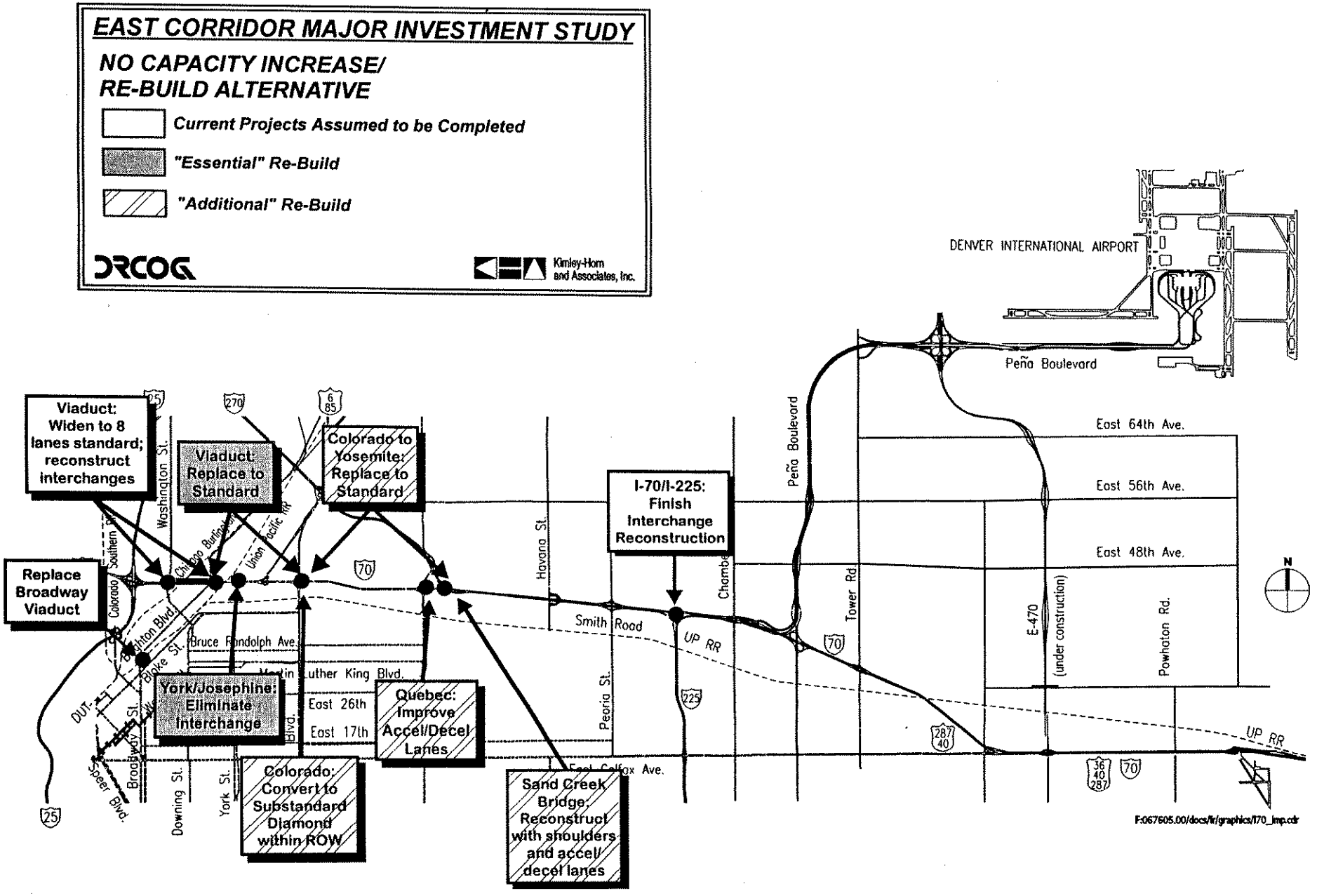
EAST CORRIDOR MAJOR INVESTMENT STUDY
NO CAPACITY INCREASE/
RE-BUILD ALTERNATIVE
Current Projects Assumed to be Completed
"Essential" Re-Build
"Additional" Re-Build
DRCOG
Kimley-Horn and Associates, Inc.
DENVER INTERNATIONAL AIRPORT
Peña Boulevard
Viaduct: Widen to 8 lanes standard; reconstruct interchanges
Viaduct: Replace to Standard
Colorado to Yosemite: Replace to Standard
I-70/I-225: Finish Interchange Reconstruction
Replace Broadway Viaduct
York/Josephine: Eliminate Interchange
Quebec: Improve Accel/Decel Lanes
Colorado: Convert to Substandard Diamond within ROW
Sand Creek Bridge: Reconstruct with shoulders and accel/decel lanes
East 64th Ave.
East 56th Ave.
East 48th Ave.
East 26th
East 17th
Smith Road
UP RR
E-470
(under construction)
Powhaton Rd.
Tower Rd.
Havana St.
Peoria St.
Washington St.
Colorado
Southern RR
Chicago Burlington
Union Pacific RR
Brighton Blvd.
Bruce Randolph Ave.
Martin Luther King Blvd.
Broadway St.
Downing St.
York St.
Speer Blvd.
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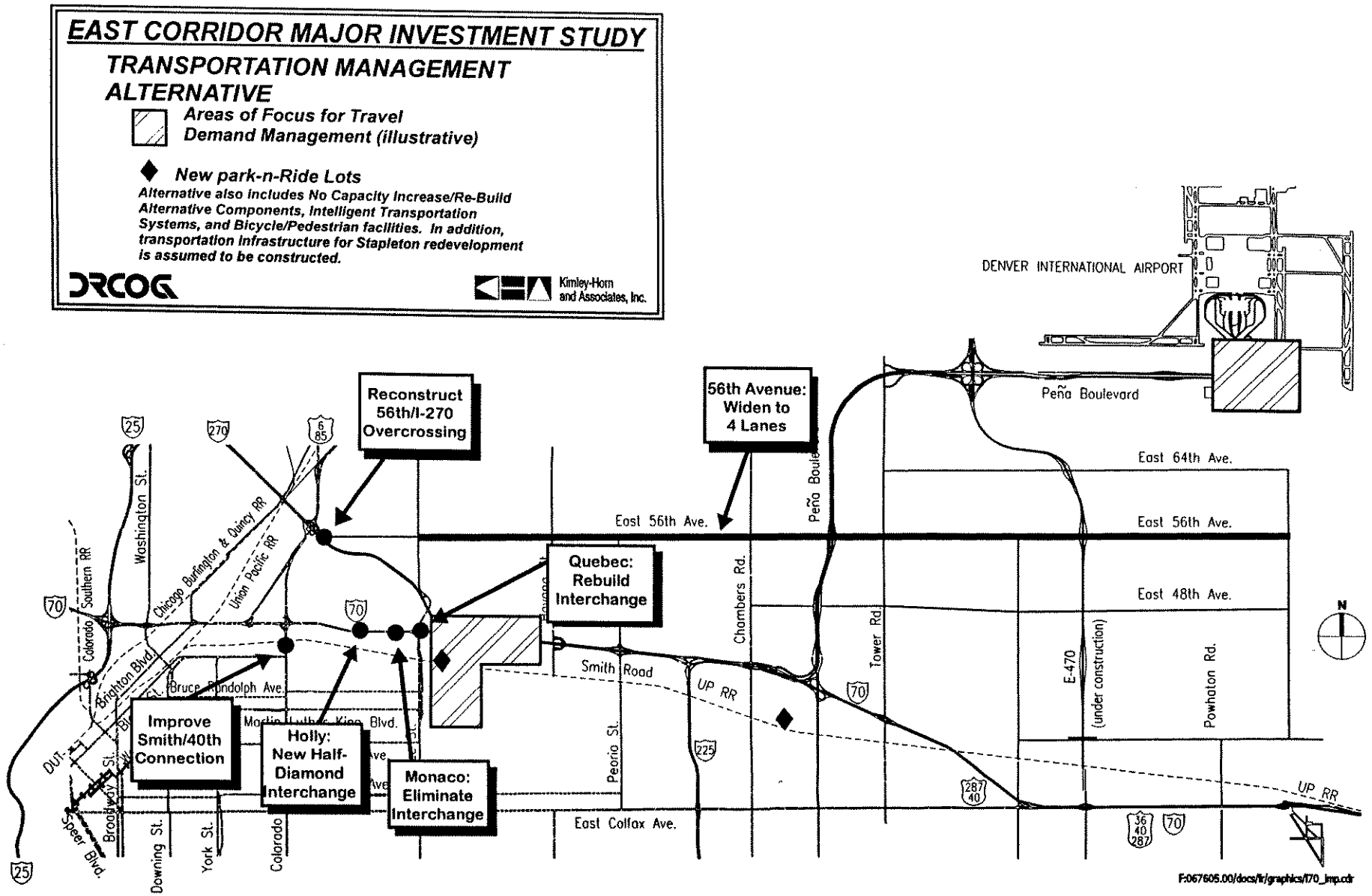
Figure 4-4


EAST CORRIDOR MAJOR INVESTMENT STUDY
TRANSPORTATION MANAGEMENT ALTERNATIVE
Areas of Focus for Travel Demand Management (illustrative)
New park-n-Ride Lots
Alternative also includes No Capacity Increase/Re-Build Alternative Components, Intelligent Transportation Systems, and Bicycle/Pedestrian facilities. In addition, transportation infrastructure for Stapleton redevelopment is assumed to be constructed.
DRCOG
Kimley-Horn and Associates, Inc.
DENVER INTERNATIONAL AIRPORT
Peña Boulevard
Reconstruct 56th/I-270 Overcrossing
56th Avenue: Widen to 4 Lanes
Quebec: Rebuild Interchange
Improve Smith/40th Connection
Holly: New Half-Diamond Interchange
Monaco: Eliminate Interchange
East 64th Ave.
East 56th Ave.
East 48th Ave.
East Colfax Ave.
Smith Road
Chambers Rd.
Tower Rd.
E-470 (under construction)
Powhaton Rd.
Peoria St.
Washington St.
Colorado
Brighton Blvd.
Broadway
Downing St.
York St.
Speer Blvd.
Chicago Burlington & Quincy RR
Union Pacific RR
Southern RR
UP RR
N
F:067605.00/docs/tr/graphics/I70_Imp.cdr

- *Alternative 3: Additional General Traffic Lanes*

  This alternative widened I-70 and Peña Blvd. for general traffic use and make numerous interchange improvements beyond the No Capacity Increase and Transportation Management alternatives. One lane was added in each direction on I-70 between Brighton Blvd. and Peña Blvd., except in the critical link between I-225 and I-270 where two lanes were added in each direction. One lane was added in each direction on Peña Blvd. Most of the Transportation Management alternative components were included. **Figure 4-5** illustrates the improvements proposed under this alternative.

- *Alternative 4: Bus/HOV Lanes*

  One lane was added in each direction on I-70 and Peña Blvd. for exclusive use by buses and carpools during most daytime hours. Direct HOV access/egress ramps would connect the I-70 Bus/HOV lanes to general traffic lanes on I-225 and I-270. A reversible Bus/HOV lane was designated for peak-period, peak-direction multi-occupant traffic on an improved Brighton Blvd. between I-70 and downtown Denver. All of the Transportation Management alternative components were included under this alternative. **Figure 4-6** illustrates the Bus/HOV alternative.

- *Alternative 5: Commuter Rail*

  This alternative proposed building a single-track (with passing track sections) commuter rail line between Denver Union Terminal (DUT) and Denver International Airport (DIA). The track followed the Union Pacific Railroad corridor from DUT to east of Chambers Rd. Two alignment options were defined and evaluated east of Chambers Rd.: one turning north and following Peña Blvd., and the other continuing east and attaining the E-470 alignment, following it north to DIA. Both alignments included five stations: DUT, 40th Ave./40th St., Stapleton, Kalispell (southwest of the I-70/Peña Blvd. interchange), and DIA. The distance from DUT to DIA is 23.5 miles following Peña Blvd., and 26 miles using E-470. The existing light rail line was extended from Downing/30th St. to the 40th Ave./40th St. station.

  Three commuter rail service technologies were examined during the development of this alternative:

  - Conventional diesel engines pulling coach cars;
  - large diesel multiple units (DMU's) such as the Siemens-Duewag VT610; and
  - small DMU's such as the Siemens-Duewag RegioSprinter.

  Service was assumed at every 20 minutes from 6:00 am to 12:00 midnight, each day of the year. Most of the Transportation Management alternative components were included. New and existing local bus services were adjusted to feed the commuter rail stations, and redundant routes altered or eliminated. **Figure 4-7** shows the commuter rail alternative.

Figure 4-5

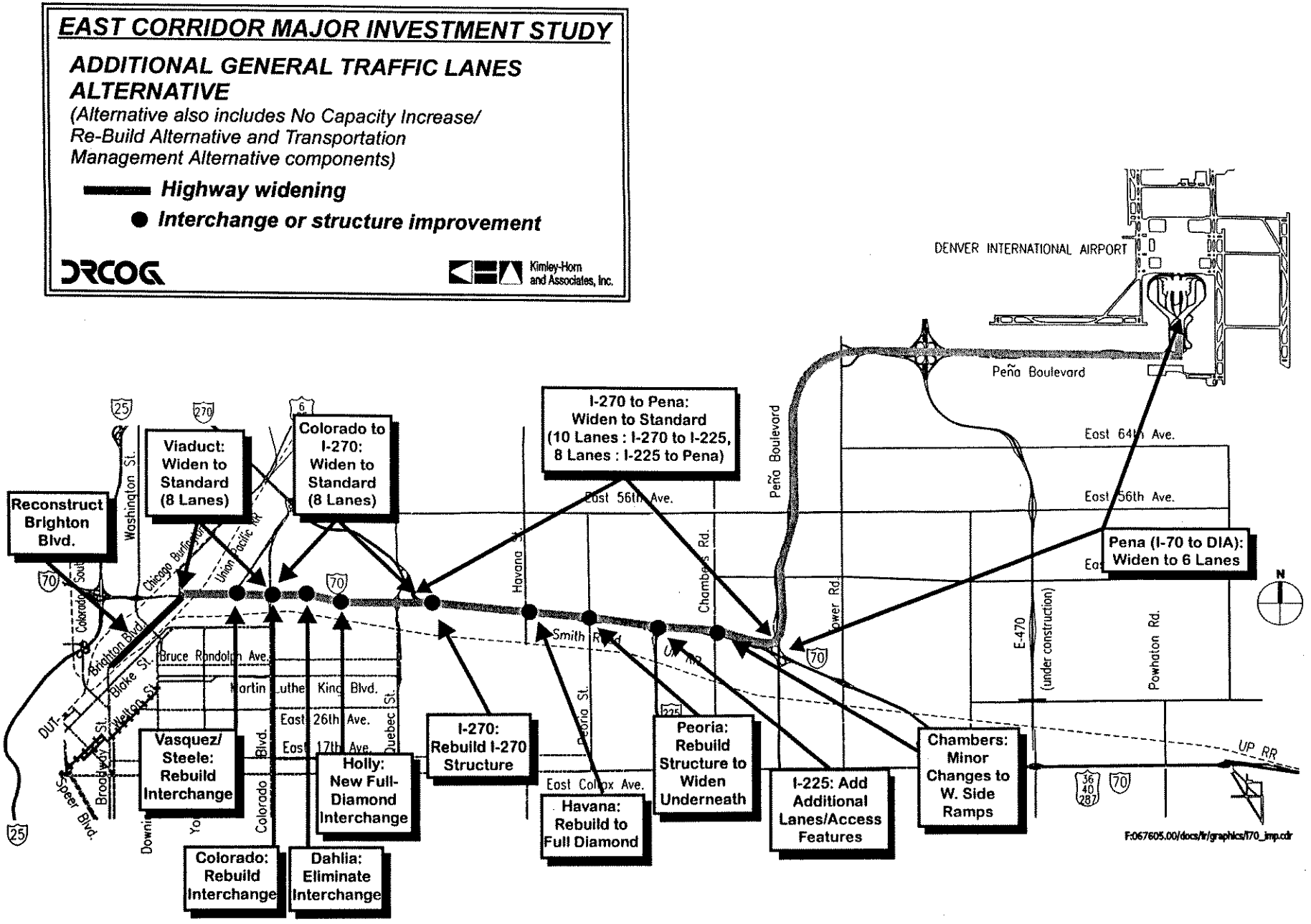

EAST CORRIDOR MAJOR INVESTMENT STUDY
ADDITIONAL GENERAL TRAFFIC LANES ALTERNATIVE
(Alternative also includes No Capacity Increase/ Re-Build Alternative and Transportation Management Alternative components)
Highway widening
Interchange or structure improvement
DRCOG
Kimley-Horn and Associates, Inc.
DENVER INTERNATIONAL AIRPORT
Peña Boulevard
Reconstruct Brighton Blvd.
Viaduct: Widen to Standard (8 Lanes)
Colorado to I-270: Widen to Standard (8 Lanes)
I-270 to Pena: Widen to Standard (10 Lanes : I-270 to I-225, 8 Lanes : I-225 to Pena)
Pena (I-70 to DIA): Widen to 6 Lanes
Vasquez/ Steele: Rebuild Interchange
Holly: New Full-Diamond Interchange
I-270: Rebuild I-270 Structure
Peoria: Rebuild Structure to Widen Underneath
Havana: Rebuild to Full Diamond
I-225: Add Additional Lanes/Access Features
Chambers: Minor Changes to W. Side Ramps
Colorado: Rebuild Interchange
Dahlia: Eliminate Interchange
Washington St.
Brighton Blvd.
Bruce Randolph Ave.
East 26th Ave.
East 17th Ave.
East Colfax Ave.
East 56th Ave.
East 64th Ave.
Havana
Chambers Rd.
Peoria St.
Quebec St.
Smith Road
E-470
(under construction)
Powhaton Rd.
UP RR
Chicago Burlington & Union Pacific RR
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Figure 4-6

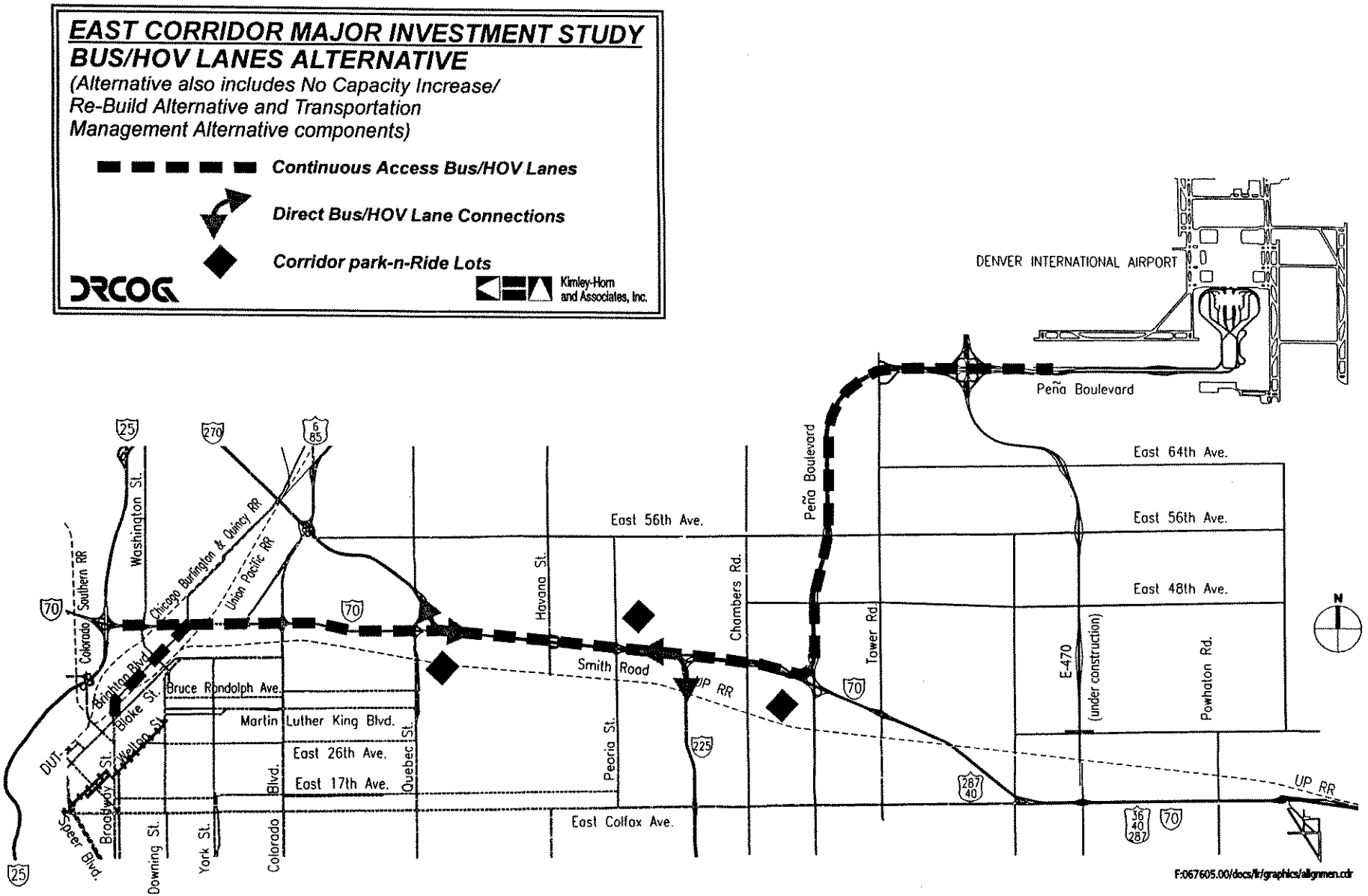
EAST CORRIDOR MAJOR INVESTMENT STUDY
BUS/HOV LANES ALTERNATIVE
(Alternative also includes No Capacity Increase/ Re-Build Alternative and Transportation Management Alternative components)
Continuous Access Bus/HOV Lanes
Direct Bus/HOV Lane Connections
Corridor park-n-Ride Lots
DRCOG
Kimley-Horn and Associates, Inc.
DENVER INTERNATIONAL AIRPORT
Peña Boulevard
East 64th Ave.
East 56th Ave.
East 48th Ave.
East 26th Ave.
East 17th Ave.
East Colfax Ave.
Martin Luther King Blvd.
Bruce Randolph Ave.
Smith Road
UP RR
Chicago Burlington & Quincy RR
Union Pacific RR
Southern RR
Washington St.
Colorado Blvd.
Brighton Blvd.
Blake St.
Wellton St.
Broadway
Speer Blvd.
Downing St.
York St.
Colorado Blvd.
Quebec St.
Havana St.
Peoria St.
Chambers Rd.
Tower Rd.
E-470 (under construction)
Powhaton Rd.
DUT
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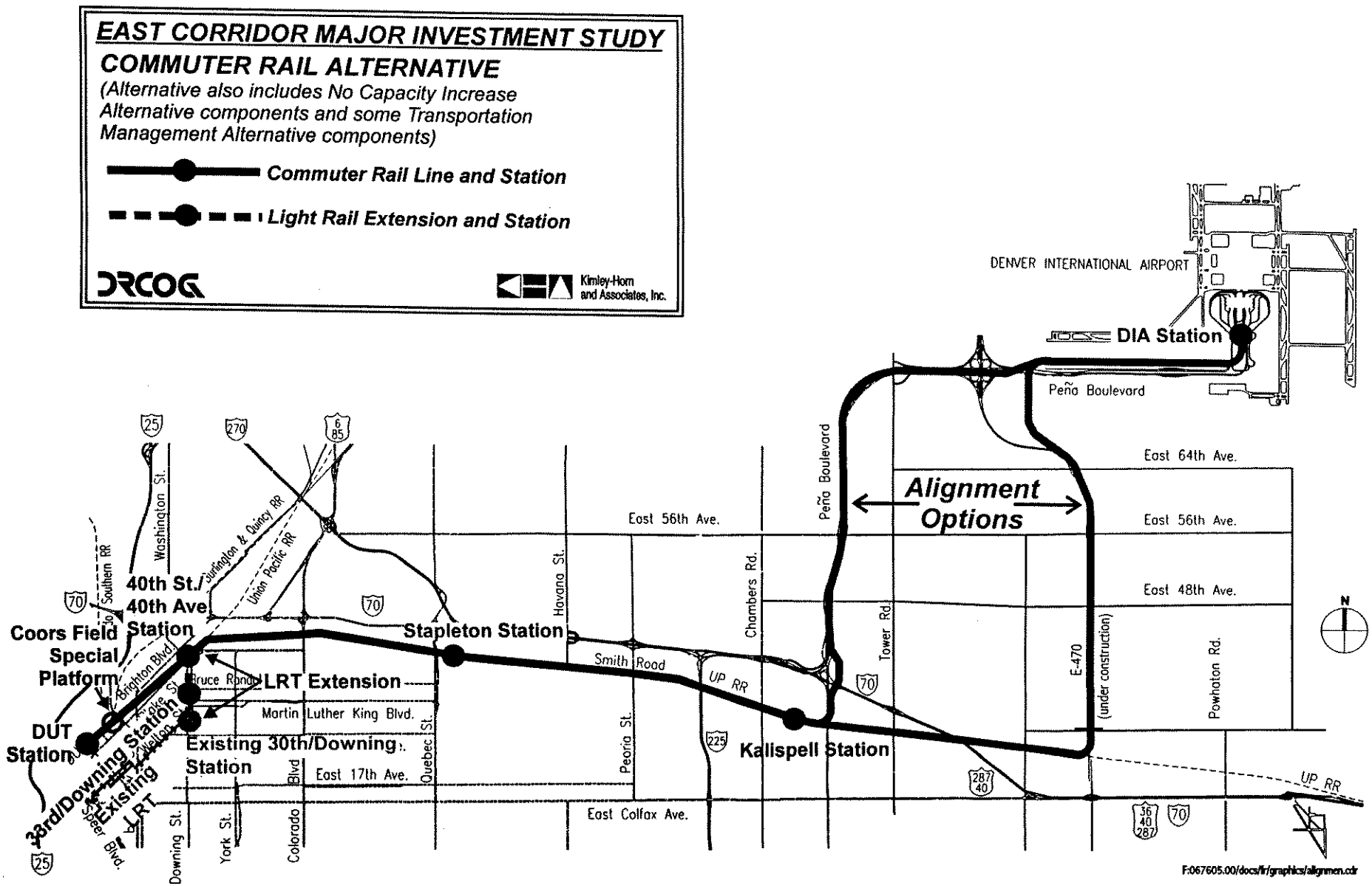
Figure 4-7


EAST CORRIDOR MAJOR INVESTMENT STUDY
COMMUTER RAIL ALTERNATIVE
(Alternative also includes No Capacity Increase Alternative components and some Transportation Management Alternative components)
Commuter Rail Line and Station
Light Rail Extension and Station
DRCOG
Kimley-Horn and Associates, Inc.
DENVER INTERNATIONAL AIRPORT
DIA Station
Peña Boulevard
East 64th Ave.
Alignment Options
East 56th Ave.
East 48th Ave.
East Colfax Ave.
Peña Boulevard
Chambers Rd.
Tower Rd.
E-470
(under construction)
Powhaton Rd.
Havana St.
Peoria St.
Quebec St.
Smith Road
UP RR
Stapleton Station
Kallispell Station
LRT Extension
Bruce Randolph
Martin Luther King Blvd.
Existing 30th/Downing Station
40th St./40th Ave Station
Coors Field Special Platform
DUT Station
38th/Downing Station
Existing LRT
Brighton Blvd.
Washington St.
Southern RR
Burlington & Quincy RR
Union Pacific RR
Downing St.
York St.
Colorado Blvd.
East 17th Ave.
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- *Alternative 6: Light Rail*

  In this alternative, a double-track rail line was constructed between DUT and DIA, generally within the UPRR alignment between downtown Denver and Tower Rd., and then on arterial streets north and east to DIA (see **Figure 4-8**). The existing central corridor LRT line was extended as single track from Downing/30th St. to a 40th Ave./40th St. station on the new double track LRT line. Thirteen stations were proposed along the line at approximately two-mile intervals. Two service options were considered: one had 10-minute service to every station, the other had 20-minute express service with limited stops between DUT and DIA interlined with 20-minute local service for all stations (except DUT). New and existing local bus services in the Corridor were revised to feed the LRT stations as appropriate, and redundant bus service was eliminated. Most of the Transportation Management alternative components were included in the light rail alternative.

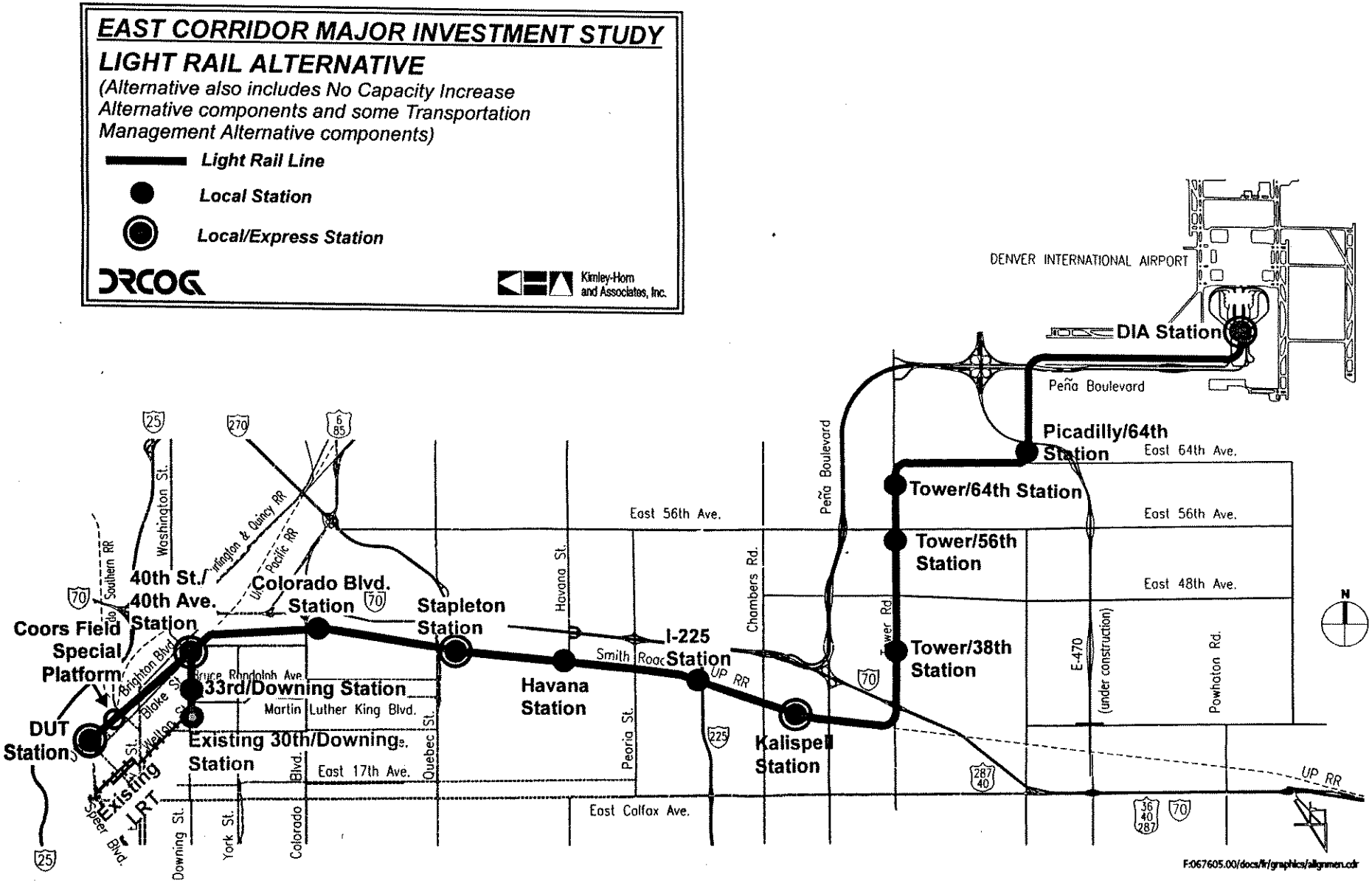
4.4.2 Evaluation of Detailed Level Alternatives

Each alternative was evaluated according to criteria defined in the MIS Guidance Manual, which embraced a multiple-measures approach based on regional goals and policies. This level of evaluation required fairly detailed estimates of capital and operating/maintenance costs to determine affordability and cost-effectiveness measures. Capacity and operating assumptions within each alternative also were defined to forecast their mobility benefits using DRCOG's regional transportation model, and their air quality impacts based upon the Colorado Department of Health's emissions model. The assessment of community and natural resource impacts required facility alignments to be related to the location of specific resources, based on existing databases and supplemented by field surveys.

The key criteria used under each category were:

- Mobility Benefits (computed reflecting average weekday conditions from the DRCOG travel model):
  - Change in Year 2020 daily regional vehicle miles of travel;
  - Change in Year 2020 daily regional person hours of delay;
  - Change in Year 2020 daily regional linked transit trips;
  - Year 2020 users of the Major Investment (daily and peak hour, peak direction);
  - Additional person-carry capacity of the Major Investment;
  - Year 2020 travel times by mode between key trip origins and destinations;
  - Reliability of travel times for travelers using the Major Investment;
  - Year 2020 volume to capacity ratios on key freeway segments; and
  - Benefits to freight movement in the Corridor.

Figure 4-8


EAST CORRIDOR MAJOR INVESTMENT STUDY
LIGHT RAIL ALTERNATIVE
(Alternative also includes No Capacity Increase Alternative components and some Transportation Management Alternative components)
Light Rail Line
Local Station
Local/Express Station
DRCOG
Kimley-Horn and Associates, Inc.
DENVER INTERNATIONAL AIRPORT
DIA Station
Peña Boulevard
Picadilly/64th Station
East 64th Ave.
Tower/64th Station
East 56th Ave.
Tower/56th Station
East 48th Ave.
Tower/38th Station
E-470
(under construction)
Powhaton Rd.
Chambers Rd.
Havana St.
Peoria St.
Quebec St.
Colorado Blvd.
Downing St.
York St.
Washington St.
Southern RR
Burlington & Quincy RR
Union Pacific RR
40th St./ 40th Ave. Station
Colorado Blvd. Station
Stapleton Station
Havana Station
I-225 Station
Kalispell Station
Coors Field Special Platform
DUT Station
Existing LRT
Existing 30th/Downing Station
33rd/Downing Station
Brighton Blvd.
Bruce Randolph Ave.
Martin Luther King Blvd.
East 17th Ave.
East Colfax Ave.
Smith Road
UP RR
N
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- Costs:
  - Total and annualized capital costs;
  - Annual operating and maintenance costs; and
  - Total annualized cost.
- Cost-Effectiveness:
  - Total annualized cost per user;
  - Total annualized cost per new user;
  - Total annualized cost per vehicle mile of travel reduced; and
  - Total annualized cost per person hour of delay reduced.
- Impacts:
  - Number of businesses displaced;
  - Number of residential units displaced;
  - Number of homes remaining within 300 feet of the Major Investment;
  - Number of streets closed;
  - Number and types of hazardous materials sites potentially disturbed;
  - Environmental justice impacts (impacts to low-income and minority areas, including number of homes displaced in those areas, number of homes remaining within 300 feet of the Major Investment in those areas, and assessment of whether the benefits of the transportation improvements were being denied to persons in those areas); and
  - Natural resources impacts (including acres of wetlands disturbed, parkland taken, wildlife refuges taken, and archaeologic properties impacted; number of historic properties taken; number of endangered species likely affected; and air pollution impacts).

Tables 4-5 through 4-9 include key information from the evaluation of the six alternatives. **Table 4-10** highlights the main differences among the four "build" alternatives from the cost, mobility, and impacts analyses, and from the assessment of how well each alternative addresses the goals, policies, issues, and travel markets identified in the corridor purpose and need. Information presented for the Commuter Rail alternative in all these tables reflects conventional diesel locomotives pulling bi-level coach cars on the E-470 alignment. Sensitivity testing shows minimal mobility differences between the technology and alignment options for Commuter Rail. The information presented in the tables for the Light Rail alternative reflects the express-local service plan option described earlier. While this service option had the most public support, its projected year 2020 daily ridership was about 1,600 persons per day lower than under the all-"local" service option.

Based on the detailed evaluation of the final six alternatives and agency and public input, no *single* alternative emerged as the "best" solution to meet the major transportation goals for the corridor. Specifically:

- Travel conditions under the No Capacity Increase alternative are extremely congested; it is not an acceptable option.
- Transportation Management activities are helpful and warrant inclusion, but by themselves do not provide significant travel improvement.

Table 4-5
Mobility Benefits of Alternatives
(Estimates for Year 2020, Average Weekday)

Criteria	No Capacity Increase Alternative	Transp. Management Alternative	Additional General Lanes Alternative	Bus/HOV Lanes Alternative	Commuter Rail (via E-470) Alternative	Light Rail Alternative
Regional Transportation Measures (Daily)						
Change in Vehicle Miles Traveled; (base = 73,695,000)[1]	Base[1]	*-47,000*	*+20,000*	*-115,000*	*-127,000*	*-151,000*
Change in Person-Hours of Delay; (base = 659,300)[1]	Base[1]	*-20,700*	*-61,200*	*-41,900*	*-29,700*	*-30,300*
Change in Linked Transit Trips; (base = 231,300)[1]	Base[1]	*+4,900*	*+6,100*	*+7,100*	*+9,100*	*+11,100*
Corridor Measures - Major Investment						
Major Investment Capacity per Direction (persons per hour) - Project/*Maximum Potential*	NA	NA	2,800/ *2,800*[2]	3,850/ *11,500*	900/ *3,600*	2,250/ *13,500*
Use of Major Investment (peak hour/ peak direction) at maximum load point	NA	NA	2,800[2]	3,850	750	1,000
Users of Major Investment (daily)	NA	NA	180,000[3]	118,000[4]	12,900	15,300
Travel time: auto/HOV/transit (*headway*) from CBD to DIA in A.M. peak hour	37/37/46(*60*)	36/36/46(*60*)	31/31/41(*60*)	33/30/40(*60*)	36/36/40(*20*)	36/36/43(*20*)
Travel Time Reliability	Poor	Fair	Fair	Fair+	Very Good	Good
Benefits to Freight Movement	Poor	Fair+	Very Good	Good	Fair-	Fair

[1] Base refers to Year 2020 conditions without increased capacity in the Corridor

[2] For one additional directional freeway lane (reflecting the majority of the corridor). Between I-270 and I-225, this alternative adds two lanes per direction; statistics therein are doubled.

[3] Only 27,600 are "new."

[4] Only 6,300 are "new" (1,600 transit, 4,700 carpool)

Table 4-6
Costs and Affordability of Alternatives
(Figures in millions of 1995 dollars)

Criteria	No Capacity Increase - Re-Build Alternative	Transp. Management Alternative	Additional General Lanes Alternative	Bus/HOV Lanes Alternative	Commuter Rail (via E-470) Alternative	Light Rail Alternative
Major Investment Only						
Capital Cost	NA	NA	$252	$293	$327	$523
Annual Operating and Maintenance Cost	NA	NA	$1.8	$4.4	$22.1	$17.7
Total Annualized Cost	NA	NA	$22.1	$28.0	$48.5	$59.8
Complete Alternative						
Capital Cost	$20	$96	$305	$337	$374	$571
Capital Cost Affordability (budget $390M)	within budget	within budget	within budget	within budget	within budget	34% above budget
Annual Operating and Maintenance Cost	$0.1	$13.6	$15.6	$14.9	$33.7	$29.2
Total Annualized Cost	$1.7	$21.3	$40.1	$42.0	$63.4	$75.1

NA = not applicable, alternative is not a major investment.

Table 4-7
Cost-Effectiveness of Alternatives
(Major Investment Options Only)

Criteria	Additional General Lanes Alternative	Bus/HOV Lanes Alternative	Commuter Rail (via E-470) Alternative	Light Rail Alternative
Corridor Measures - Major Investment Only				
Total Annualized Cost/User	$0.36	$0.79	$11.60	$12.06
Annualized Cost Per Incremental User	$2.35	-	-	-
Regional Measures - Compared to Base				
Annualized Cost Per Incremental User	-	$9.39	$20.00	$19.38
Annualized Cost Per Vehicle Mile of Travel Reduced	increases VMT	$0.96	$1.41	$1.40
Annualized Cost Per Person Hour of Delay Reduced	$2.33	$3.59	$8.20	$9.52

Table 4-8
Community Impacts of Alternatives

Criteria	No Capacity Increase - Re-Build Alternative	Transp. Management Alternative	Additional General Lanes Alternative	Bus/HOV Lanes Alternative	Commuter Rail (via E-470) Alternative	Light Rail Alternative
Displacements						
▸ Residences	3	3	14-20	14-20	0	0
▸ Businesses *(employees)*	1 (*45*)	1 (*45*)	12 (*440*)	12 (*440*)	0	0
Disruption--Remaining Homes within 300'	127	273	275	275	197	197
Streets Closed*	0	0	0	0	5 +/-	5 +/-
Hazardous Materials: Number of sites *(anticipated impacts)*	7 sites (*no impacts*)	7 sites (*no impacts*)	11 sites (*no impacts*)	11 sites (*no impacts*)	56 sites (*no impacts)*	56 sites (*no impact*)
Environmental Justice Considerations						
▸ miles bisecting minority or low-income areas//total miles of alternative	1.5/5	7.5/17	12/31.5	14/33.5	14.5/39	14.5/38
▸ residences acquired in minority or low-income areas/total residences acquired	3/3	3/3	14-20/14-20	14-20/14-20	NA	NA
▸ residences remaining within 300' in minority or low-income areas/total residences remaining within 300'	127/127	273/273	275/275	275/275	197/197	197/197
▸ benefits denied to minority or low income areas	NA	No	No	No	No	No

* note: all alternatives include the elimination of the York/Josephine interchange on I-70

Table 4-9
Natural Resource Impacts of Alternatives

Criteria	No Capacity Increase - Re-Build Alternative	Transp. Management Alternative	Additional General Lanes Alternative	Bus/HOV Lanes Alternative	Commuter Rail (via E-470) Alternative	Light Rail Alternative
Wetlands Disturbed (acres)	< 1 acre	< 1 acre	1-2 acres	1-2 acres	1-2 acres	1-2 acres
Parklands and Wildlife Refuge Taken (acres)	none	none	none	none	none	none
Historic Properties Taken	none	none	none	none	none (7 props. within 400', no sig. negative impacts)	none (7 props. within 400', no sig. negative impacts)
Endangered Species: number (*anticipated impact*)	10 (*no impact*)	10 (*no impact*)	10 (*no impact*)	10 (*no impact*)	10 (*no impact*)	10 (*no impact*)
Air Quality						
Change in Corridor tons/day						
- Carbon Monoxide (base = 88.49)[1]	Base[1]	-.77	-1.05	-1.61	-1.45	-1.36
- Nitrous Oxides (base = 15.29)[1]	Base[1]	-.01	+.54	+.02	-.07	-.03
- Particulates (base = 7.45)[1]	Base[1]	-.03	+.05	-.04	-.06	-.05
Change in Regional tons/day						
- Carbon Monoxide (base = 947.34)[1]	Base[1]	-6.22	-19.62	-14.16	-9.95	-9.85
- Nitrous Oxides (base = 165.30)[1]	Base[1]	-.02	+.42	-.24	-.19	-.20
- Particulates (base = 83.25)[1]	Base[1]	-.07	-.21	-.17	-.15	-.14

[1] Base refers to Year 2020 conditions without increased capacity in the Corridor.

Table 4-10
Summary of Detailed Level Alternatives Evaluation

	General Traffic Lanes Alternative	Bus/HOV Lanes Alternative	Commuter Rail Alternative	Light Rail Alternative
Mobility	+Most reduction in person hours of delay +Most daily users - Increases vehicle miles of travel	+Many potential users, largely due to nature of air passenger travel to DIA +Reduces vehicle miles of travel - Peña Blvd. HOV lanes likely saturated at times - The one remaining general traffic lane in the peak direction on Brighton Blvd. south of I-70 would be seriously congested.	+Most reliable travel time to DIA + Reduces vehicle miles of travel - Little impact on peak period congestion	+ Highest transit ridership + Lowest vehicle miles of travel + Most potential capacity - Little impact on peak period congestion
Cost and Cost-Effectiveness	+Least costly +Least cost/user	+Low cost per user, VMT reduced, and person hour of delay reduced	+ Low cost per VMT reduced -High cost per user, and person hour of delay reduced	- Beyond corridor budget + Low cost per VMT reduced - High cost per user, and person hour of delay reduced
Impacts	- Homes and businesses displaced +No significant natural resource impacts	- Homes and businesses displaced +No significant natural resource impacts	+ No homes or businesses displaced + No significant natural resource impacts	+ No homes or businesses displaced + No significant natural resource impacts

(+ = positive attribute; - = negative attribute)

Table 4-10 (cont.)
Summary of Detailed Level Alternatives Evaluation

	General Traffic Lanes Alternative	Bus/HOV Lanes Alternative	Commuter Rail Alternative	Light Rail Alternative
Travel Markets	+Serves all major travel markets in Corridor	+Serves through-trip and airport travel markets -Does not serve inner beltway and internal corridor travel markets well	+Serves airport travel market -Does not serve through trip, inner beltway, and internal corridor travel markets well	+Serves internal corridor and airport travel markets -Does not serve through trip and inner beltway travel markets well
Corridor Issues	+Reconstructs aging infrastructure +Adds continuous east-west roadways +Addresses freeway safety problems +Relieves congestion at bottlenecks +Helps contain congestion to peak hours +Best serves freight traffic	+Reconstructs aging infrastructure +Adds continuous east-west roadways +Addresses freeway safety problems +Provides some improvements for freight traffic	+Able to serve growth around stations +Adds continuous east-west roadways +Adds another east-west transportation link	+Able to serve growth around stations +Adds continuous east-west roadways +Adds another east-west transportation link +Serves transit-dependent populations best
Regional Goals and Policies	+Implements ITS +Improves freeway safety - Inconsistent with regional goals and policies as a sole investment strategy in Corridor	+Enhances existing transit option to DIA +Implements ITS +Minor energy savings through VMT reduction +Improves freeway safety	+Implements new form of rapid transit in Corridor, which reduces VMT and offers optional mode to airport +Most competitive travel time between transit and automobile +Minor energy savings through VMT reduction	+Implements new form of rapid transit in Corridor, which reduces VMT and offers optional mode to airport +Implements ITS +Minor energy savings through VMT reduction

(+ = positive attribute; - = negative attribute)

- The Additional General Traffic Lanes alternative reduces, but does not eliminate, congestion. It also provides benefits to all Corridor travel markets, which none of the other alternatives do independently.

- Widening the freeway system as the only improvement is not consistent with regional planning objectives.

- The cost to construct light rail in this corridor significantly exceeds the funds expected to be available.

4.5 Package Alternatives and Findings

4.5.1 Improvement Packages

To best serve the corridor's major travel markets, respond to critical corridor issues, and address regional transportation goals, two *packages* or combinations of improvements based upon elements of several of the detailed alternatives were advanced for additional study. Some components were modified (from what was presented in the detailed alternatives) as they were incorporated into these two packages.

Each package included completion of the following committed and essential projects:

- Reconstruction of I-70 between Washington and Brighton (widening to eight lanes and rebuilding the Brighton interchange);

- Reconstruction of the I-225/I-70 interchange;

- Replacement of the Broadway railroad viaduct with a four-lane underpass;

- Reconstruction of the Colorado bridge over I-70 and the I-70 bridges over Sand Creek;

- Reconstruction and upgrade of the I-70 viaduct between Brighton and Colorado; adding shoulders but not through lanes, and

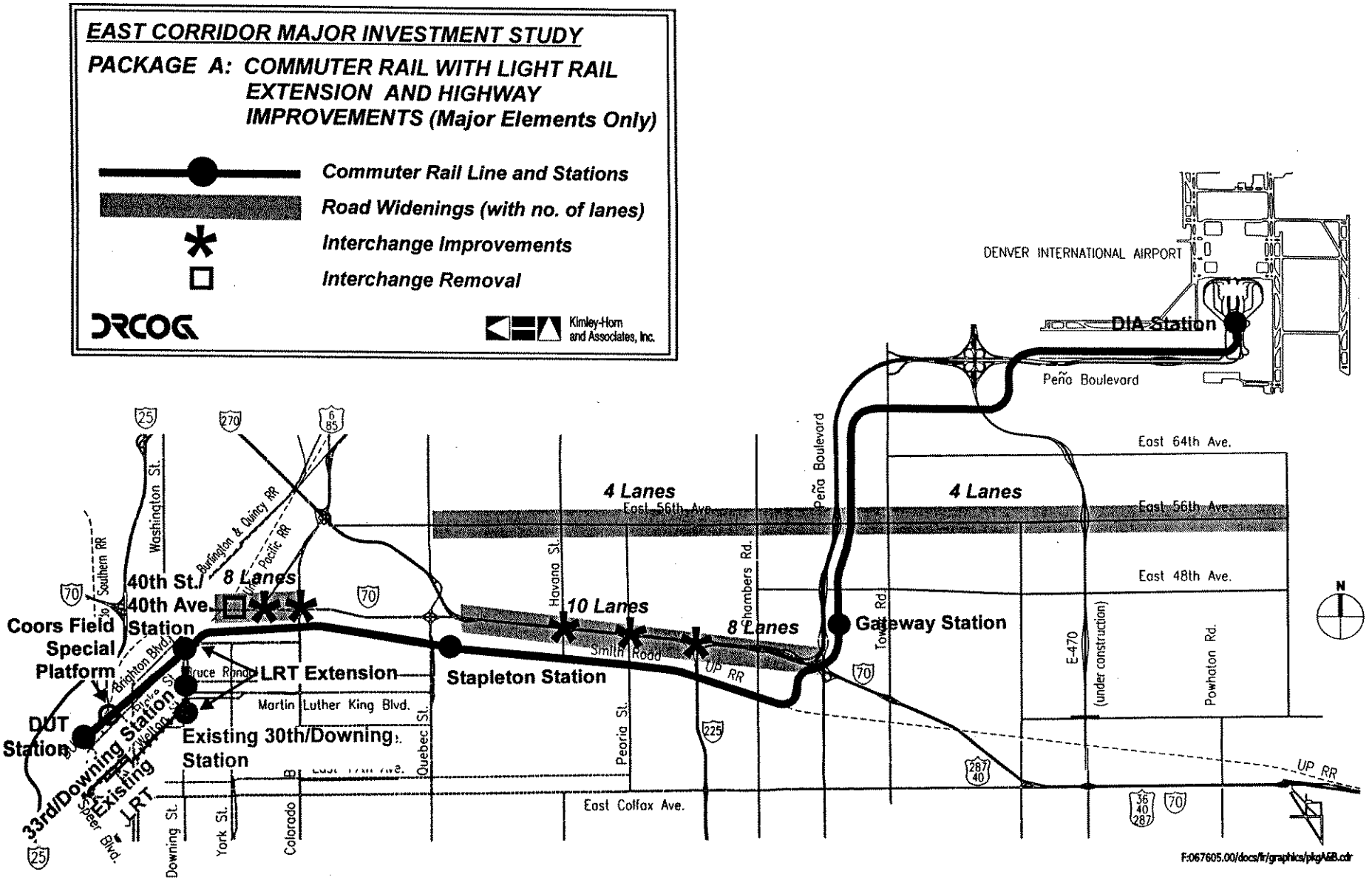
- Construction of transportation infrastructure supporting Stapleton redevelopment.

None of these projects counted against the corridor budget. Additional characteristics of each package are described in the following sections.

- *Package A: Commuter Rail, Light Rail Extension, and Widening of Critical Freeway Segments*

In this package (see **Figure 4-9**), single-track commuter rail between downtown Denver and DIA was combined with widening the most severely congested segments of I-70. Commuter rail in this package would follow the Union Pacific Railroad right-of-way between DUT and the Laredo St. alignment east of Chambers Rd., before turning north and east through the I-70/Peña Blvd./Airport Blvd. interchange complex. The alignment would then be along the east side of Peña Blvd., from 100 to 1,000 feet from the freeway, but within the Peña Blvd. right-of-way. It would cross north under Peña Blvd. east of the E-470 interchange (at the Picadilly location) for the final segment to the DIA terminal.

Figure 4-9


EAST CORRIDOR MAJOR INVESTMENT STUDY
PACKAGE A: COMMUTER RAIL WITH LIGHT RAIL EXTENSION AND HIGHWAY IMPROVEMENTS (Major Elements Only)
Commuter Rail Line and Stations
Road Widenings (with no. of lanes)
Interchange Improvements
Interchange Removal
DRCOG
Kimley-Horn and Associates, Inc.
DENVER INTERNATIONAL AIRPORT
DIA Station
Peña Boulevard
East 64th Ave.
4 Lanes
East 56th Ave.
4 Lanes
East 56th Ave.
East 48th Ave.
40th St./40th Ave. Station
8 Lanes
10 Lanes
8 Lanes
Gateway Station
Coors Field Special Platform
LRT Extension
Stapleton Station
DUT Station
Existing 30th/Downing Station
33rd/Downing Station
Existing LRT
Martin Luther King Blvd.
East Colfax Ave.
Smith Road
UP RR
E-470
(under construction)
Powhaton Rd.
Havana St.
Chambers Rd.
Tower Rd.
Peoria St.
Quebec St.
Washington St.
Southern RR
Burlington & Quincy RR
Union Pacific RR
Brighton Blvd.
Bruce Randolph
Welton St.
Downing St.
York St.
Colorado
Speer Blvd.
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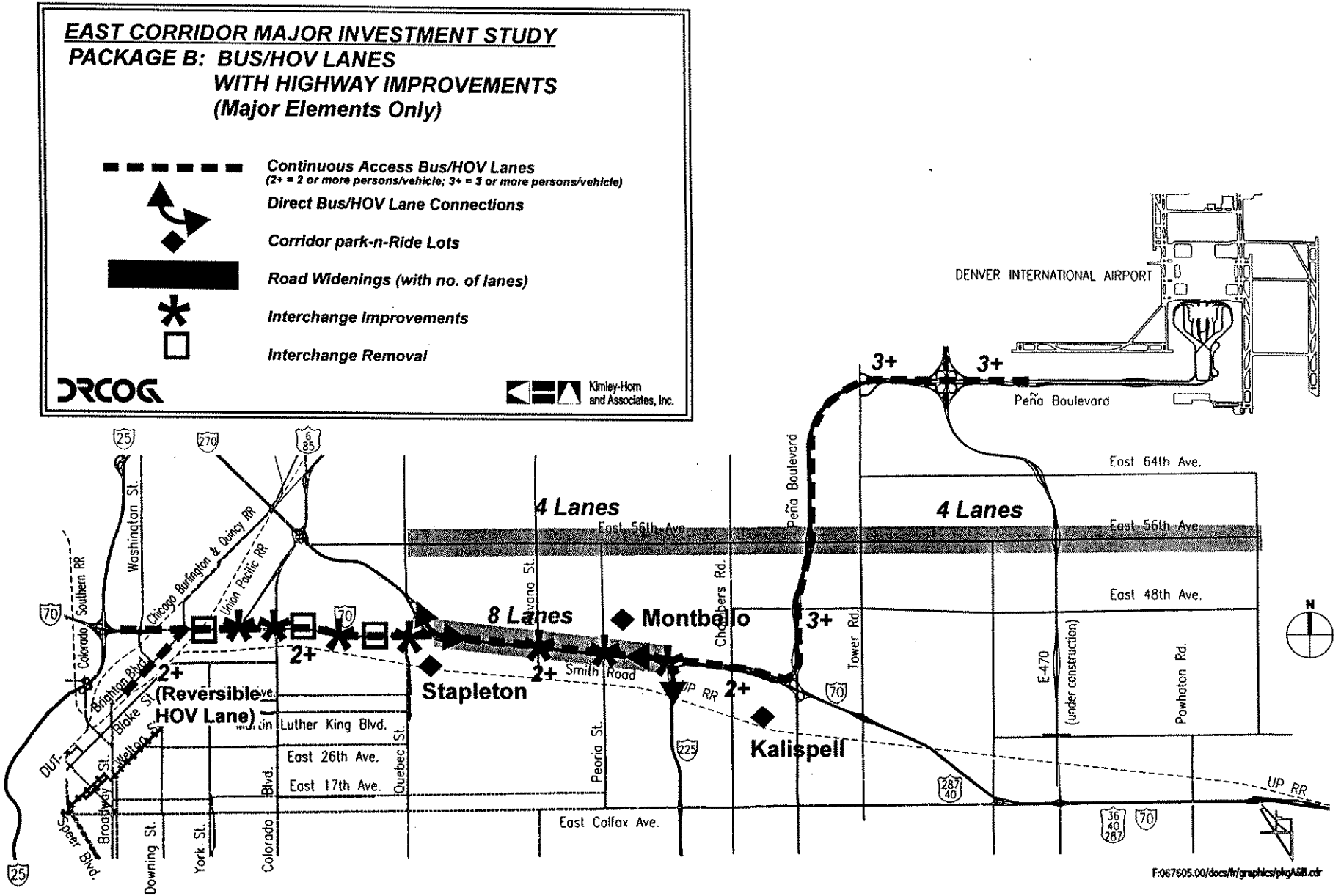
The Kalispell Station included in the previous commuter rail alternative was eliminated, and a new Gateway Station was added at Peña Blvd. and 40th Ave. This new alignment and station configuration were developed in concert with Air Train proponents and Denver and Aurora staff and policymakers. The east side of Peña Blvd. is a preferable commuter rail alignment over the median of Peña Blvd. for two key reasons. First, the east side alignment proposed eliminates the need for expensive structures to get into and out of the Peña median (it crosses beneath Peña in an existing structure). Second, the Gateway Station would be easier to access, particularly by pedestrians from (future) adjacent businesses. Other stations would be located at DUT, 40th St./40th Ave., Stapleton, and DIA. Parking would be provided at the 40th St./40th Ave., Stapleton, and Gateway stations.

Commuter rail operating characteristics would be the same as the original commuter rail alternative, but large Diesel Multiple Units (DMUs) were assumed which lowered projected operating costs. The existing central corridor LRT line would be extended from its present terminus at Downing and 30th St. to the 40th Ave./40th St. commuter rail station. In Package A, I-70 was widened to eight lanes between Brighton Blvd. and Colorado Blvd., ten lanes between I-270 and I-225, and eight through lanes between I-225 and Peña Blvd. Transportation management improvements intended to reduce congestion, reduce travel demand, improve safety, and encourage transit use were also included.

- *Package B: Bus/HOV Lanes and Widening I-70 between I-270 and I-225*

This package (see **Figure 4-10**) would add continuous access Bus/HOV lanes from I-25/I-70 to DIA and one general traffic lane in each direction on I-70 between I-270 and I-225. Direct ramps would connect I-70 HOV lanes with general traffic lanes on I-225 and I-270. Bus/HOV access to downtown would be improved by widening Brighton Blvd. to five lanes between I-70 and the Broadway underpass (current viaduct), with a reversible HOV lane during peak periods. The I-70 HOV lanes would be limited to two or more persons per vehicle, while the Peña Blvd. lanes would be specified at three or more persons per vehicle, due to the large number of multi-occupant vehicles traveling to and from DIA. The Bus/HOV lane construction would include complete reconstruction of all freeway components from Brighton to I-225. SkyRide bus service to DIA was enhanced by adding new routes and modifying existing ones to make better use of the Bus/HOV lanes. Transportation management improvements intended to reduce congestion, reduce travel demand, improve safety, and encourage transit use were also included.

Figure 4-10


EAST CORRIDOR MAJOR INVESTMENT STUDY
PACKAGE B: BUS/HOV LANES
WITH HIGHWAY IMPROVEMENTS
(Major Elements Only)
Continuous Access Bus/HOV Lanes
(2+ = 2 or more persons/vehicle; 3+ = 3 or more persons/vehicle)
Direct Bus/HOV Lane Connections
Corridor park-n-Ride Lots
Road Widenings (with no. of lanes)
Interchange Improvements
Interchange Removal
DRCOG
Kimley-Horn and Associates, Inc.
DENVER INTERNATIONAL AIRPORT
Peña Boulevard
3+
3+
4 Lanes
East 56th Ave.
4 Lanes
East 56th Ave.
East 64th Ave.
East 48th Ave.
8 Lanes
Montbello
3+
2+
2+
2+
2+
(Reversible HOV Lane)
Stapleton
Kalispell
Smith Road
UP RR
UP RR
Martin Luther King Blvd.
East 26th Ave.
East 17th Ave.
East Colfax Ave.
Washington St.
Chicago Burlington & Quincy RR
Union Pacific RR
Colorado Southern RR
Brighton Blvd.
Bloke St.
Wellton St.
Broadway St.
Speer Blvd.
Downing St.
York St.
Colorado Blvd.
Quebec St.
Peoria St.
Havana St.
Chambers Rd.
Tower Rd.
E-470
(under construction)
Powhaton Rd.
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4.5.2 *Evaluation of Improvement Packages*

The two improvement packages were evaluated in the same manner as the six detailed level alternatives. Capital and operating/ maintenance costs were estimated for each, and their mobility benefits were estimated through travel forecasting. Community and natural resource impacts were assessed based on previous work for the relevant components of the detailed level alternatives. The packages were also evaluated as to their ability to serve corridor travel markets, address corridor transportation issues, and meet regional goals and policies.

Tables 4-11 through 4-14 summarize the mobility benefits, costs, cost-effectiveness, and community and natural resource impacts of each package. "No Capacity Increase" alternative statistics for some mobility measures are presented as a base case for comparison.

Mobility Benefits

As shown in **Table 4-11**, each package performed roughly the same in terms of increasing transit trips and reducing delay. Package B outperformed Package A in terms of numbers of users and VMT reduction. Package A performed better in reducing congestion on critical segments of I-70. Both packages reduced travel times from downtown Denver to DIA for all modes. In the modeling context, Package B showed slightly better travel times for transit than Package A, while Package A showed slightly better travel times for single-occupant vehicles. However, the transit travel time of Package B would not be very reliable; buses would be subject to delays due to freeway incidents and weather, for example. The commuter rail transit travel time in Package A was considered very reliable, immune to the types of delays that would affect bus/HOVs. Overall, the two packages were considered nearly equivalent with respect to mobility; the reliability of Package A gave it a slight superiority.

Users of each package include transit riders, carpoolers, and general traffic lane users. Use of the *added* person capacity was estimated at three key locations, and was generally high relative to the capacity increment added. The commuter rail capacity was tailored in terms of trainset size and frequency to meet projected demand.

Cost and Cost-Effectiveness

Although the mobility benefits of each package were similar, **Table 4-12** shows that Package B's lower capital and operating costs made it more cost-effective per user, per VMT reduced, and per person hour of delay reduced than Package A. Cost-effectiveness measure differences between the two packages were much less than the differences between the six detailed alternatives. In other words, combining the most effective components of individual alternatives significantly reduced differences in cost-effectiveness.

Table 4-11
Mobility Benefits of Investment Packages
(Estimates for Year 2020, Average Weekday)

Criteria		Base Case[1]	Package A	Package B [2]
Regional Transportation Measures (Daily)				
Change in Vehicle Miles Traveled (base = 73,695,000)[1]		Base[1]	*-44,000*	*-105,000*
Change in Person-Hours of Delay (base = 659,300)[1]		Base[1]	*-59,600*	*-59,000*
Change in Linked Transit Trips (base = 231,300)[1]		Base[1]	*+8,800*	*+8,400*
Corridor Measures				
Users Per Day	General Lane Addition	NA	108,000	73,200
	HOV Lane	NA	NA	52,700
	Transit	NA	12,900	10,100
	Total	NA	121,000	136,000
Package* Capacity per Direction (persons per hour)				
- west of Vasquez/Steele		NA	3,565	3,850
- east of I-270		NA	6,365	6,650
- north of 40th Ave.		NA	765	5,650
Package* Use (persons per hour) (peak hour/peak direction)				
- west of Vasquez/Steele		NA	3,050	2,100
- east of I-270		NA	5,900	6,100
- north of 40th Ave.		NA	700	1,800
Freeway Volumes (all day, both direction)				
- west of Vasquez/Steele		143,000	157,000	144,000
- east of I-270		198,000	225,000	209,000
- north of 40th Ave.		110,000	114,000	110,000
Freeway volume-to-capacity ratio (peak hour/peak direction)				
- west of Vasquez/Steele		1.17	1.01	1.17
- east of I-270		1.39	1.10	1.19
- north of 40th Ave.		1.12	1.12	1.09
Travel time: auto/HOV/transit (*headway*) from CBD to DIA				
in - A.M. peak hour		37/37/46(*60*)	32/32/40(*20*)	33/30/36(*20*)
- P.M. peak hour		46/46/57(*60*)	38/38/40(*20*)	40/32/37(*20*)
Transit Travel Time Reliability		Poor	Very Good	Fair to Good

[1] Base refers to Year 2020 conditions without increased capacity in the Corridor.

[2] Package B volumes include High Occupancy Vehicles.

* Statistics reported for major elements of the packages (i.e., commuter rail, Bus/HOV lanes, and additional freeway lanes).

Table 4-12
Costs and Cost-Effectiveness of Investment Packages
(Figures in millions of 1995 dollars)

Criteria	Package A	Package B
Capital Cost	$465	$308
Capital Cost Affordability (budget $390M)	$75 above budget	$82 below budget
Annual Operating and Maintenance Cost	$31.7	$18.9
Total Annualized Cost	$69.7	$45.1
Total Annualized Cost Per Annual User	$1.60	$0.90
Annualized Cost Per Vehicle Mile of Travel Reduced	$4.35	$1.15
Annualized Cost Per Person Hour of Delay Reduced	$4.40	$2.75

Table 4-13
Community Impacts of Investment Packages

Criteria	Package A	Package B
Displacements:		
Residences	14-20 (based on width of buffer chosen)	14-20 (based on width of buffer chosen)
Playground	To be replaced by other acquisitions	To be replaced by other acquisitions
Businesses (employees)	9 Businesses (total) -York to Steele: 3 (10-20 emps) -Steele to RR spur: 2 (80-170 emps) -RR spur to Colorado: 4 (40*-230 emps)	9 Businesses (total) -York to Steele: 3 (10-20 emps) -Steele to RR spur: 2 (80-170 emps) -RR spur to Colo: 4 (40*-230 emps)
Remaining residences within 300'	327	275
Streets closed	5 +/-	0

*Former Anderson News building is currently vacant; previous employment estimated at 175.

Table 4-14
Performance of Packages Relative to Travel Markets, Corridor Issues, and Regional Goals and Policies

Travel Markets	Package A	Package B
"Inner Beltway" Trips	Very Good	Good
"Through" Trips	Very Good	Good
"Airport" Trips	Good	Good
"Internal" Trips	Very Good	Good
East Corridor Transportation Issues		
Few continuous east-west transportation facilities	Very Good	Good
Traffic congestion on I-70	Fair to Good	Poor to Fair
Accident rate on I-70	Good	Very Good
Heavy truck traffic	Good	Fair to Good
Aging infrastructure	Good	Very Good
Transit dependents	Fair to Good	Fair
Growth	Fair to Good	Fair
Regional Goals and Policies		
Increase system capability for efficient movement	Good	Good
Implement rapid transit to reduce VMT and need for more roadway capacity	Fair	Good
Provide travel time advantage to rapid transit	Achieved when incidents arise	Not achieved
Reduce mobile source emissions	*	*
Emphasize alternative modes	Good	Good
Provide multi-modal options to DIA	Very Good	Good
Minimize energy consumption	Fair	Fair to Good
Implement ITS	Very Good	Very Good
Design safe and efficient facilities	Good	Very Good

* Estimated to be approximately equivalent with small regional benefits.

Community and Natural Resources Impacts

Evaluation of each package's impacts was based on previous impact analyses for the six detailed alternatives. There were no significant impacts anticipated to wetlands, parks, historic properties, endangered species, and hazardous material sites. Air quality impacts were also assessed for the six detailed alternatives, and no significant impacts were found. Accordingly, there would be no significant air quality impacts associated with either package.

Table 4-13 indicates that both packages displace the same number of residences and businesses, and encroach onto the Swansea Elementary School property. This encroachment would be addressed through subsequent environmental studies, and could be mitigated by replacing the school playground property with an adjacent property to be acquired. Numerous residences would remain within 300 feet of an improved facility; however, virtually *all* of these residences are *currently* within 300 feet of a major transportation facility. Package A would close sections of approximately five streets, mostly along the Downing LRT extension and perhaps between York and Steele on the commuter rail line.

The two packages are essentially equal with respect to environmental justice considerations. Both improve *existing* transportation corridors which already traverse low income and minority neighborhoods. Because there are essentially no other business or residences immediately adjacent to I-70 in other parts of the Corridor, displacements in both packages are entirely within these predominantly minority areas. Mitigation of these impacts would be addressed through the Environmental Impact Statement (EIS) process.

Service to Major Travel Markets in the East Corridor

An assessment of how well each package serves the four major East Corridor travel markets described earlier in Section 3.4 is shown in **Table 4-14.** While both packages address each of the four major travel markets to a high degree, Package A does so slightly better. Specifically:

- Package A serves "Inner Beltway" trips best by adding two general traffic lanes in each direction on I-70 between I-225 and I-270, reducing congestion for all trips in this travel market;

- Package A improves conditions the most for the "Through Trip" travel market since the additional widening on I-70 is for general traffic. The Bus/HOV lanes of Package B would have virtually no impact on the travel behavior for longer inter-regional and interstate trips using I-70. They would improve conditions for some intra-regional trips, such as carpools traveling between the east (or southeast) and west parts of the region via I-70 (such as Watkins to Golden, or central Aurora to Arvada).

- Both packages serve "Airport" trips. Package A serves downtown to DIA trips best since travelers would be immune to incident-related congestion on the freeway system. Longer trips to

DIA would best be served by Package B, since a transfer to commuter rail would not be necessary. SkyRide service from Lakewood and Arvada, shuttle service from the mountains, and any multi-person party originating west of I-25 could derive benefit from Package B's HOV lanes.

- Package A serves "Internal" trips best, since it offers superior access to jobs in downtown Denver and at DIA via commuter rail, and reduces congestion on critical I-70 links used by shorter commute trips. (Generally speaking, the Bus/HOV lanes in Package B serve longer commute trips where travelers can offset the extra time for carpool formation or waiting for a bus with faster travel times on the highway). Both packages include management activities that make improvements to 56th Ave. and Smith Rd. which would provide substantial enhancements for local trips.

East Corridor Transportation Issues Addressed

A number of important transportation issues were raised in East Corridor early in the process of identifying the purpose and need for transportation improvements. These issues and the relative abilities of Packages A and B to address them are shown in **Table 4-14.**

While both investment packages address the majority of corridor transportation issues, Package A addresses them better than Package B. Specifically:

- Each package addresses the need for more continuous east-west roadways by connecting Smith Road across Stapleton and widening East 56th Ave. to four lanes. In addition, Package A establishes a new east-west public transportation facility (the commuter rail line).

- Projected year 2020 peak-period congestion is reduced, but not eliminated, where general traffic lanes are provided. Package A reduces the peak hour volume-to-capacity ratio on both highly-congested segments of I-70. Package B reduces it only on the most critical segment of I-70, and to a lesser degree than Package A. Neither package reduces peak-hour volumes below designed road capacity.

- Package B reconstructs the entirety of the I-70 corridor, including all interchanges, to modern standards, which should reduce accident rates. While Package A leaves a short weaving section between Vasquez and Colorado ramps and does not reconstruct the segment of I-70 between Colorado and I-270, this segment has one of the lower accident rates on I-70 west of I-225. Package A does improve the most hazardous segments of the freeway.

- With respect to heavy truck traffic, Package A adds freeway capacity in critical sections and reconstructs several key interchanges. The additional capacity, useable by all vehicles including trucks, will decrease peak hour congestion and will tend to further reduce congestion during non-peak

periods and the "shoulders" of the peaks which are important movement times for trucks. Package B adds freeway capacity in the most critical section and reconstructs all interchanges in this reach of I-70.

- Package B addresses aging infrastructure by reconstructing all of I-70 in the East Corridor. Package A reconstructs all but the segment currently in the best condition.

- Neither package provides a major investment immediately within neighborhoods with substantial transit dependents, but this is consistent with stated neighborhood desires to minimize community impacts. Both packages provide transit service from neighborhoods to major transit transfer points, either express bus or commuter rail. Package A does extend LRT within an area of substantial transit dependents, increasing direct accessibility to points farther south on that line.

- Commuter rail in Package A has the potential to serve development around its stations quite well, and has the potential to encourage growth around those stations. Bus/HOV in Package B is flexible and enables service to development as it occurs, but has little potential to encourage growth in specific locations.

Consistency With Regional Transportation Policies and Goals

Regional transportation policies and goals relevant to the East Corridor MIS also are indicated in **Table 4-14.** Neither package can be considered clearly superior with respect to addressing these policies and goals. Specifically:

- A DMU train set (Package A) can carry more passengers per operator than can be carried on a bus (Package B), however, Package B better serves other multi-occupant vehicles (carpoolers, shuttles, etc.);

- Both packages implement forms of rapid transit. Package B reduces VMT more than Package A does, and could accommodate more persons per hour than single track commuter rail.

- In neither package does the transit element have a time savings over "normal" (non-incident) highway travel. However, both are substantially more time-competitive to the auto than the base case during normal highway traffic conditions. Commuter rail in Package A can provide reliable rapid service even when incidents stop or slow freeway and Bus/HOV traffic; during incidents, commuter rail of Package A would enjoy a time savings over auto travel.

- Air pollutant emissions models were not run for these packages, but previous modeling of mobile source emissions for the six independent alternatives showed small regional benefits from any technology option. These packages are expected to be generally similar in emissions impacts.

- Both packages emphasize alternative modes.

- Both packages provide a multi-modal option to DIA. Commuter rail in Package A introduces an entirely new transit option in the corridor which has considerable appeal to the public;

- Package B reduces VMT the most, consequently reducing energy consumption the most.

- Each package incorporates similar Intelligent Transportation Systems (ITS) elements.

- Both packages will be designed to be safe and efficient; more of the freeway is rebuilt in Package B than Package A.

Other Observations

There are several issues regarding Package B, as follows:

- The route and means proposed for bus and HOV traffic from I-70 to downtown Denver in Package B provide no real benefits over general traffic. Furthermore, an improved Brighton Blvd. would still have limitations since it is an industrial street, with back-in loading docks fronting it, head-in parking adjacent to it, and numerous curb cuts. General traffic would still need to use the Bus/HOV lane to make turns, and the "reversible" operation adds to operating cost and safety concerns. The Broadway underpass also cannot accommodate an extra lane, so the length of this "enhanced" bus and HOV provision would be a little more than a mile. Closer to downtown, the buses routed to DUT would follow Blake and Market, both of which have back-in loading docks for several blocks. Signals in this area favor the viaduct pairs from I-25 (19th/20th and 22nd/23rd); progression along both Blake and Market is poor. Also, pedestrian and vehicular traffic associated with Coors Field events seriously disrupts other traffic on Blake and Market.

- To eliminate poor CBD access as a drawback to this package, it was suggested that another means to link I-70 to downtown should be specified. Conceptually, it would be possible to build a "new" HOV roadway generally paralleling the UP railroad tracks from DUT to I-70. Such a facility could be constructed for a capital cost on the order of $100 million. Package B's capital and operating costs, even after including this roadway, would still be less than Package A's. However, a flyover would be required to directly connect this facility and the Bus/HOV lanes on I-70. This would cause the I-70 viaduct to be widened even more adjacent to the residential neighborhood, and visual concerns about the flyover would be expected.

- There is substantial debate as to how effective continuous-access Bus/HOV lanes are in removing users from traffic flow problems on general purpose lanes. Many U.S. cities have such lanes, and the level of success is directly linked to a long-term commitment to enforcement and penalty for misuse, and an operating protocol that keeps the Bus/HOV lanes

restricted to Bus/HOV use except under the most dire of general lane incidents.

- Both packages have assumed the "essential" reconstruction of the viaduct (but without additional laneage) to be done "off-budget;" perhaps with discretionary funds. The Bus/HOV lanes of Package B cannot proceed without the concurrent commitment of approximately $100 million for this essential reconstruction. Similarly, one portion of the highway widening of Package A could not proceed, but other widening, commuter rail implementation, and light rail extension could.

4.5.3 Conclusion

Table 4-15 summarizes the relative strengths of each package according to categories of evaluation criteria. Because the packages were crafted so as to address as many of the issues, markets, goals, and other factors as possible, it is not surprising that in most respects they are extremely competitive. Of the major topics, Package B is superior only on the basis of cost (and therefore cost-effectiveness).

Table 4-15 also introduces the element of public support. The vast majority of public sentiment expressed at public meetings, neighborhood gatherings, focus groups and similar forums has been for some form of rail technology. The project team heard little public support for the Bus/HOV lane technology of Package B expressed during the nearly two years of this study.

A major issue during the consideration of these two packages was freeway widening in the I-70 viaduct area, essentially the only residential "neighborhood" impacted by any action along I-70. Community leaders and local elected officials representing that area concluded that the displacement impacts reflected in **Table 4-13** were not supportable, nor were additional takings that might result from a flyover connection to a bus/HOV roadway to the CBD. The bus/HOV lanes of Package B cannot be implemented without widening in the viaduct area, so this concern is fatal to that package. The freeway widening in the viaduct area can be eliminated from Package A without completely crippling that alternative.

Following review of the two packages by the Committee of Technical Staff, the Policy Level Advisory Committee, and the public, a modified version of Package A, with the following provisions, was endorsed as the recommended Corridor Investment:

- The investment must include the Downing light rail connection to the commuter rail alignment to ensure connectivity to other areas in the region.

- The project must not preclude conversion of commuter rail to light rail.

- It was recommended that replacement of the I-70 viaduct between Brighton and Colorado only include widening to bring the shoulders to standard. It was noted, however, that during the Environment Impact Statement (EIS) process, widening to accommodate additional lanes may be considered in

Table 4-15
Summary of Evaluation of Packages

Criteria	Package A	Package B
Mobility	✔	
Cost/Cost-Effectiveness		✔
Community & Natural Resource Impacts	Equal	Equal
Travel Markets Served	✔	
Corridor Issues Addressed	✔	
Relationship to Regional Goals	Equal	Equal
Other Observations	✔	
Public Support for Technology	✔	

✔ = Alternative better addresses the topic.

this segment. It was clearly noted that additional through lanes are not now the preference, but they may warrant consideration at the time the EIS is prepared.

- I-70, between I-270 and I-225, should be widened to five lanes in each direction to help alleviate congestion along the corridor, with transitional laneage to Peña Blvd.

- The investment must ensure connectivity with (future) rapid transit in the I-225 corridor.

- The investment also includes elements of Transportation System Management (TSM) and Transportation Demand Management (TDM) strategies that contribute to the performance of the package as a whole. These include widening East 56th Ave. to four lanes, local bus improvements, intelligent transportation systems infrastructure, and bicycle/pedestrian connections.

Details of the recommended improvements are presented in Chapter 5.

5 RECOMMENDED CORRIDOR INVESTMENT

5.1 Overview

The evaluation of transportation alternatives resulted in the selection of a combined investment package which includes commuter rail, light rail, widening of critical freeway segments, and various transportation management strategies in the East Corridor. The combined investment approach is necessary to address multiple objectives within the corridor. Details about each of the components are included in sections 5.2, 5.3, and 5.4. Key performance statistics for the recommended corridor investment are presented in section 5.5.

5.2 Rail Components

5.2.1 Introduction

Commuter rail is designed to provide service between major urban origins and destinations with few intervening stops. In this recommendation, commuter rail would link the Denver CBD to DIA. With intermediate stops at 40th St./40th Ave., Stapleton, and the Gateway area, commuter rail has the potential to serve existing and new development surrounding those stations and to carry commuters bound for the CBD and air passengers bound for DIA.

5.2.2 Summary of Key Elements

The commuter rail concept proposed for the East Corridor includes the following elements:

- A single-track commuter rail line with passing track sections would be constructed between the Denver Union Terminal (DUT) in lower downtown Denver and DIA, generally following the Union Pacific Railroad alignment to east of Chambers Rd., where it turns north through the I-70/Peña Blvd. interchange, and then runs along the east side of Peña Blvd. into the south end of the DIA terminal. The single-track construction would not preclude future expansion to double-track operations, or conversion to light rail transit.

- The Central Corridor LRT line would be extended in a single-track configuration one mile north to intersect the commuter rail line.

- Intervening stations would be established at the LRT/commuter rail interface (40th St./40th Ave.), at Stapleton, and in the Gateway area. A connection to a future I-225 rapid transit line could also be made in the general vicinity of where the UPRR tracks pass under I-225. An additional light rail station would be constructed at 33rd and Downing.

- New and existing RTD bus service would be oriented to feed commuter rail as appropriate.

- Vehicle technology recommended for use on the commuter rail line is a self-propelled diesel car operating singly or in short trains (called diesel multiple-

units or DMUs). The specific DMU technology recommended uses large vehicles with performance characteristics similar to conventional diesel push/pull technology.

The general alignment of the commuter rail alternative is shown in **Figure 5-1**. Typical cross-sections for commuter rail are shown in **Figures 5-2 and 5-3**.

5.2.3 Commuter Rail Physical Characteristics

Alignment Description

Commuter rail would connect Denver Union Terminal (DUT) in lower downtown Denver and Denver International Airport (DIA). From DUT to Laredo St. (east of Chambers Rd.) in Aurora, a distance of approximately 11 miles, a new single-track commuter rail mainline and passing sidings would be constructed within the Union Pacific Railroad (UPRR) right-of-way to the south of the existing freight tracks. The right-of-way allows for potential double-track construction and operations in the future.

For purposes of this study, commuter rail would utilize the two most easterly tracks at DUT (those nearest the current building). From that point, the commuter rail track would parallel the freight mainline, immediately to the south of it. In the Stapleton area, the UPRR passes beneath the former runways in a tunnel, with the track offset to the south side of this tunnel. If the tunnel remains, there is room for a new track to be constructed north of the current track with freight traffic routed on the new track and commuter rail on the old alignment. If the tunnel is demolished as proposed by the Stapleton Development Plan, the commuter rail tracks would be constructed south of the freight tracks. This study assumes that the tunnel is removed. In either case, a new bridge across Sand Creek would be constructed. The alignment would allow for a connection with a future I-225 rapid transit line in the general vicinity of where the freeway crosses over the UP right-of-way.

No rail lines currently exist between the UPRR right-of-way and DIA. The *Air Train* study sponsored by the City and County of Denver proposed making this connection via the Peña Blvd. median, which is quite wide and could easily accommodate commuter rail within. However, to reduce costs and provide better access to commercial growth anticipated for the Gateway area, an alignment paralleling Peña Blvd. (instead of using the median of the freeway) is recommended for consideration. The line would run on the east side of Peña (within its right-of-way) as the freeway moves north from I-70. It would cross over E-470 south of the Peña Blvd./E-470 interchange and turn north towards Peña Blvd., outside of the clear zone for the future Runway 7 at DIA. The alignment would cross under Peña Blvd. just west of the existing DIA toll plaza in an existing structure. Between the DIA toll plaza and the DIA Terminal building, the commuter rail alignment would be located between 78th Ave. and Runway 25R. The commuter rail line would connect to the DIA Terminal building on the commercial vehicle level (fifth floor). The total distance from DUT to DIA in this alignment is approximately 23 miles, of which about 11 miles is along Peña.

Figure 5-1

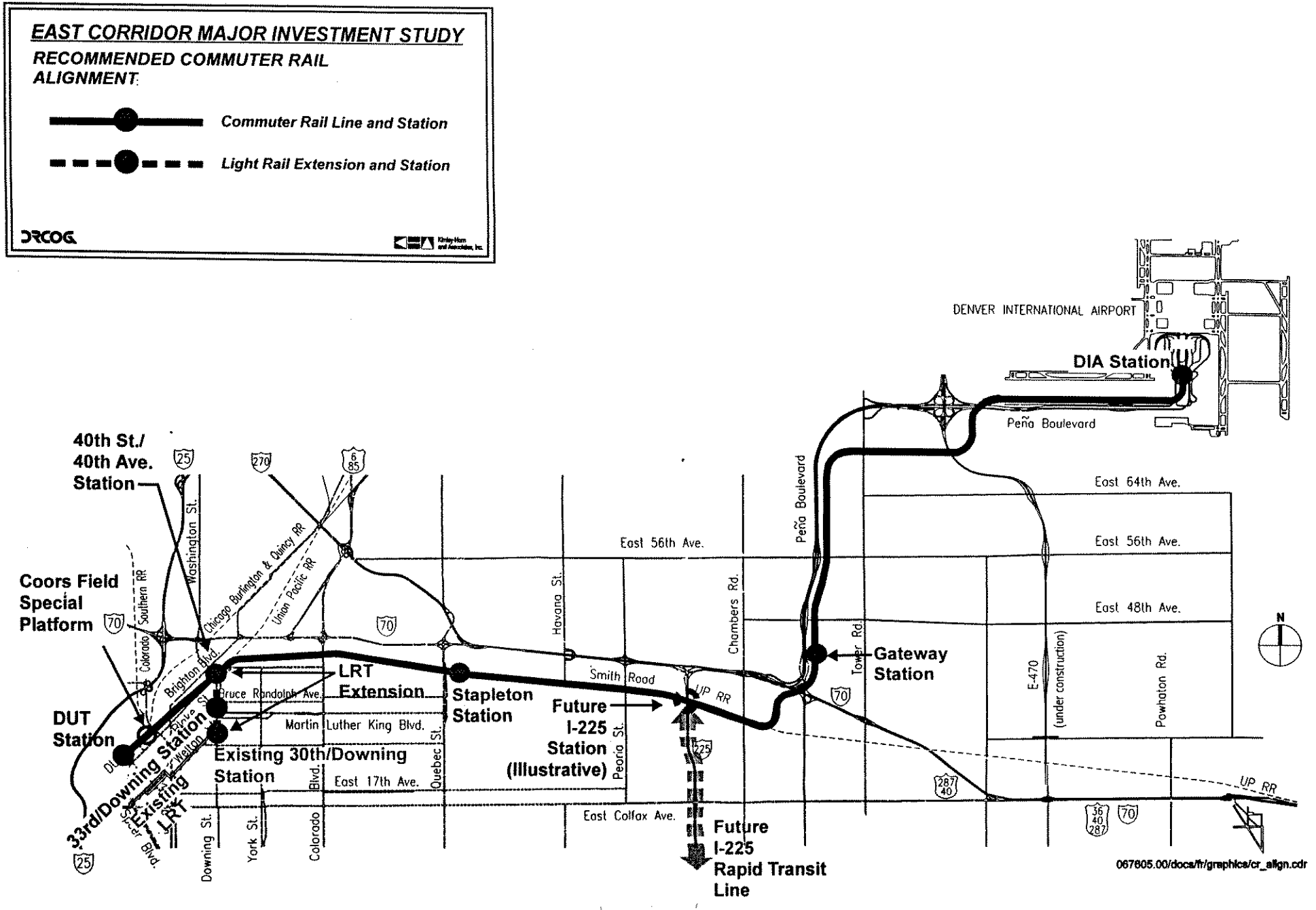

EAST CORRIDOR MAJOR INVESTMENT STUDY
RECOMMENDED COMMUTER RAIL ALIGNMENT
Commuter Rail Line and Station
Light Rail Extension and Station
DRCOG
DENVER INTERNATIONAL AIRPORT
DIA Station
Peña Boulevard
40th St./ 40th Ave. Station
Coors Field Special Platform
DUT Station
33rd/Downing Station
Existing LRT
Existing 30th/Downing Station
LRT Extension
Stapleton Station
Future I-225 Station (Illustrative)
Gateway Station
Future I-225 Rapid Transit Line
Washington St.
Chicago Burlington & Quincy RR
Union Pacific RR
Southern RR
Colorado
Brighton Blvd.
Bruce Randolph Ave.
Martin Luther King Blvd.
East 17th Ave.
East Colfax Ave.
Downing St.
York St.
Colorado Blvd.
Quebec St.
Peoria St.
Havana St.
Smith Road
UP RR
Chambers Rd.
Tower Rd.
E-470 (under construction)
Powhaton Rd.
East 64th Ave.
East 56th Ave.
East 48th Ave.
N
067605.00/docs/fr/graphics/cr_align.cdr

Figure 5-2
Typical Cross-Section for Commuter Rail Using Railroad Right-of-Way

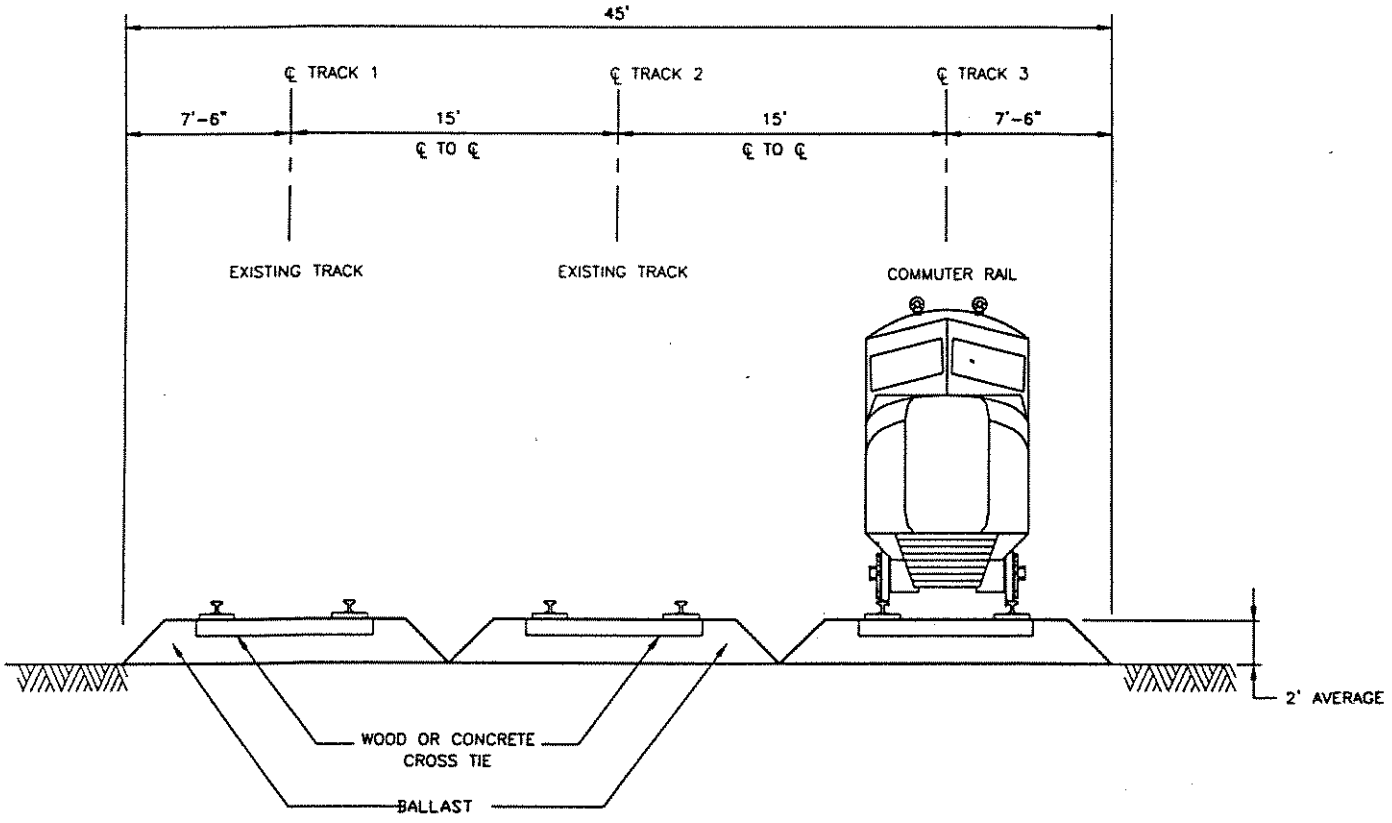
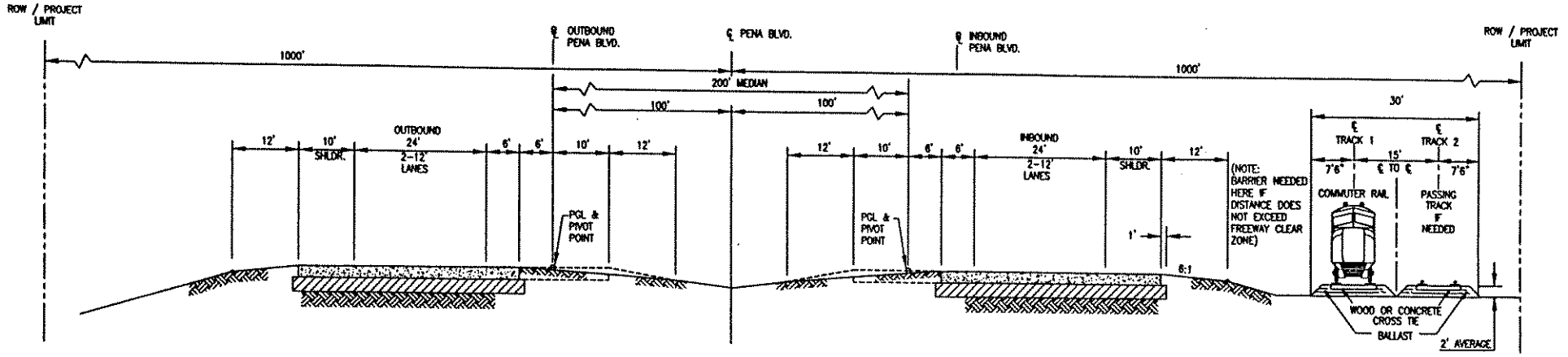


Figure 5-3
Typical Cross-Section for Commuter Rail Along Peña Blvd.



To achieve good travel times, a commuter rail train will need to operate at maximum speed north of I-70. While this area is currently sparsely developed, numerous plans and proposals are in some stage of the planning/zoning process. Future planning and engineering efforts to implement commuter rail should work closely with adjacent property owners to ensure desired commuter rail speeds and operating characteristics are realized.

Track Structure

The track structure for commuter rail would be designed and constructed in accordance with Federal Railroad Administration (FRA) track safety standards, American Railway Engineering Association (AREA) standards and practices, and Union Pacific Railroad standards and practices. The commuter rail line would be constructed as a single track with passing sidings as required. It would be designed and constructed so as to not preclude double-tracking in the future.

New commuter rail main and siding tracks and any relocated or upgraded UP tracks will meet FRA requirements for Class 4 track which will allow a maximum speed of 60 mph for freight trains and 80 mph for passenger trains (the existing UP main line is Class 3 track which allows maximum speed of 40 mph for freight and 60 mph for passenger trains). Turnouts will be #14 minimum (allows 30 mph) for main line track with #20 turnouts (allows 50 mph) preferred for installations where speed and ride comfort are required. Rail will be new 133 pound section on new treated timber ties.

The minimum curvature proposed for the alignment is a 450-foot radius, and the maximum gradient will be 4.8%. (While a 3.5% maximum grade is preferred for large DMUs, a short 4.8% grade segment can be operated safely at slow speeds.) Where the commuter rail line crosses over the UP main track, a minimum height clearance of 23 feet, six inches (with 25 feet preferred) will be provided.

Grade Separations with Roadways

No nationwide guidelines on thresholds for at-grade operations have been developed for commuter rail. Decisions are typically made on a case-by-case basis, depending on local and state regulations, policies and ordinances. Commuter rail is assumed to operate with preemption (in other words, absolute priority) at all at-grade crossings, much like freight rail, such that all crossing delay accrues to motorists. The MIS project teams have defined thresholds for grade separations as shown in **Table 5-1**. This guidance has not been agreed to by any railroad owner, local government, or the Public Utilities Commission, but reflects a starting point for consideration. Between DUT and Chambers Rd., **Table 5-2** shows that there are seven existing grade-separations and fifteen at-grade street crossings that would be retained in the alternative. None of the streets with at-grade crossings currently has traffic volumes in excess of the upper threshold, and only Peoria St. is expected to approach that threshold by the year 2015. For purposes of this study, a grade separation (for commuter rail only) is proposed at Peoria St. Also, in the alignment studied, new grade separations for commuter rail are assumed to be

Table 5-1
Commuter Rail Grade Separation Guidance

Headway (One Direction) in Minutes	ADT Threshold Below Which Grade Separation is not Needed	ADT Threshold Above Which Grade Separation Should Be Provided
10	20,000	45,000
15	26,000	52,500
20	32,000	60,000

Note: This guidance was prepared by the MIS project teams as a starting point for consideration and for cost estimating purposes. Final decisions on grade separations will occur among project sponsors, railroad owners, local governments, and the Public Utilities Commission during project design.

Table 5-2
Commuter Rail At-Grade Crossings and Grade Separations

Existing At-Grade Crossings	Existing Grade-Separations	Proposed New At-Grade Crossings	Proposed New Grade-Separations
York Street	20th Street	32nd Ave.	Yosemite Street
Josephine Street	23rd Street	40th Ave.	Peoria Street
Columbine Street	Broadway**	78th Ave. service road	Chambers Rd.
Clayton Street	38th Street (construct new bridge for new tracks)	Service Road Access 1	I-70 mainline
Steele Street		Service Road Access 2	Airport Blvd.
Dahlia Street			48th Avenue
Holly Street	Colorado Blvd.***		56th Avenue
Monaco Parkway	Quebec Street		Tower Road
Quebec St. frontage roads (2)	I-225		E-470
			Peña Blvd.
Ulster Street			78th Ave. service road relocated
Smith Road Spur			Outbound DIA service road relocated
Havana Street			Patsburg St.
Peoria Street*			Relocated Loop Road
Sable Boulevard			
Chambers Rd.*			

* freight operations would remain at-grade, but commuter rail track is proposed to be grade-separated
** existing viaduct to be replaced by underpass
*** bridge reconstruction funded in 1997 Transportation Improvement Program

constructed at Yosemite St. and Chambers Rd. At-grade crossings would be equipped with "smart signal" technology where appropriate so that disruptions to traffic on crossing streets could be minimized.

All new grade separation structures would be built wide enough to accommodate the potential double-tracking in the future. Initial construction of structures to accommodate two tracks adds moderate costs to the recommended Corridor Investment, but would save considerable costs related to retrofitting structures for a second track in the future.

East of Chambers Rd., the commuter rail alignment transitions out of the UP right-of-way and subsequently utilizes the eastern right-of-way of Peña Blvd. In that segment, the commuter rail line would operate at essentially the same grade as Peña Blvd., crossing intersecting streets in a grade-separated manner. East of Chambers Rd., there would be five new at-grade crossings and fourteen new grade separations, several of which are quite lengthy and cross several roadways.

Grade Separation with Railroad Tracks

Commuter rail will be grade-separated from mainline freight railroad tracks. Commuter rail does not need to be grade-separated with infrequently used freight spur tracks. For planning purposes, the MIS teams established that commuter rail would be separated from freight spur tracks if the average number of daily two-way train movements on the spur track exceeds two per day. Commuter rail would cross six spur tracks, none with more than two daily train movements. The details of these track crossings would be worked out with UPRR during preliminary engineering.

Stations

Commuter rail stations would be located at: Denver Union Terminal; 40th St./40th Ave.; Stapleton; Gateway; and the DIA Terminal. An additional station could be added to connect to a future I-225 rapid transit line to be determined.

Station features that would be provided at the commuter rail stations (as applicable) include the following:

- Ticket counter or fare collection equipment and waiting area facilities;
- ADA compliant facilities;
- Public address system and signage;
- Platform lengths of 500 feet;
- Lighting, security, and emergency systems;
- Partially covered platform tracks (two tracks, one main and one siding, are provided at each station);
- Transfer facilities with other transportation modes; and
- Parking, passenger drop-off/pick-up areas, site roadways, and landscaping.

Two commuter rail tracks would be provided at and adjacent to each station, allowing for scheduled passing or, in some instances, providing a passing alternative in the event of a schedule deviation.

Denver Union Terminal Station

Denver Union Terminal (DUT) currently is served by limited inter-city and excursion passenger rail services. Commuter rail service, along with future light rail service such as that potentially proposed for the West Corridor, would be among the most frequent service at DUT and should therefore be closest to the passenger waiting area. **Figure 5-4** shows the existing layout for the station, with commuter rail occupying the two tracks nearest the station. The facility is being considered for use as a multi-modal station and a regional hub for mass transit. Commuter rail functions could be accommodated within the current DUT facility, or within a reconfigured layout as proposed in the *DUT Intermodal Feasibility Study.*

40th St./40th Ave. Station

This station would be located near the intersection of 40th St. and 40th Ave. on the site of the current UP Intermodal Yard (see **Figure 5-5**). This station would provide both commuter rail and LRT service, in addition to local bus service. Bus bays and short-term parking spaces would be provided with access via 40th Ave. This station would provide approximately 300 long-term parking spaces between the commuter rail tracks and 40th Ave., as this station is expected to act as the terminus for park-n-Ride rail passengers from the western portions of the Denver region.

Stapleton Station

The Stapleton Station (see **Figure 5-6**) would be situated north of Smith Rd. between Quebec St. and a future extension of Syracuse St. About 600 parking spaces would be provided at this location, with the lot located on the south side of Smith Rd. and east of Syracuse, which could require demolition of an existing building. Parking at this station can serve rail passengers from the northern and northwestern portions of the Denver region.

Gateway Station

A station in the Gateway area would serve newly developing businesses and residents as well as commuters from Green Valley Ranch and Aurora. Actual siting of such a station could be a function of proposed development in the vicinity. To simplify the analysis, a prototype station was defined that fits within an open space envelope depicted in the proposed Gateway Park development. This location is along Peña Blvd. approximately 0.5 miles north of I-70 adjacent to 40th Ave. A station platform and bus bays would be provided adjacent to the rail tracks, with a park-and-ride lot of nominally 600 spaces located between the platform/bus bays and the on-ramp to Peña from 40th Ave. **Figure 5-7** provides a site plan sketch for this location.

DIA Station

The DIA terminal station (see **Figure 5-8**) would be located at the south end of the terminal building on the commercial vehicle level (level 5). The commuter rail platforms would be located outside the terminal building to avoid diesel exhaust problems. The commuter rail station would be designed so as not to preclude possible future southward expansion of the DIA terminal building.

Figure 5-4: Denver Union Terminal Commuter Rail Station Conceptual Plan

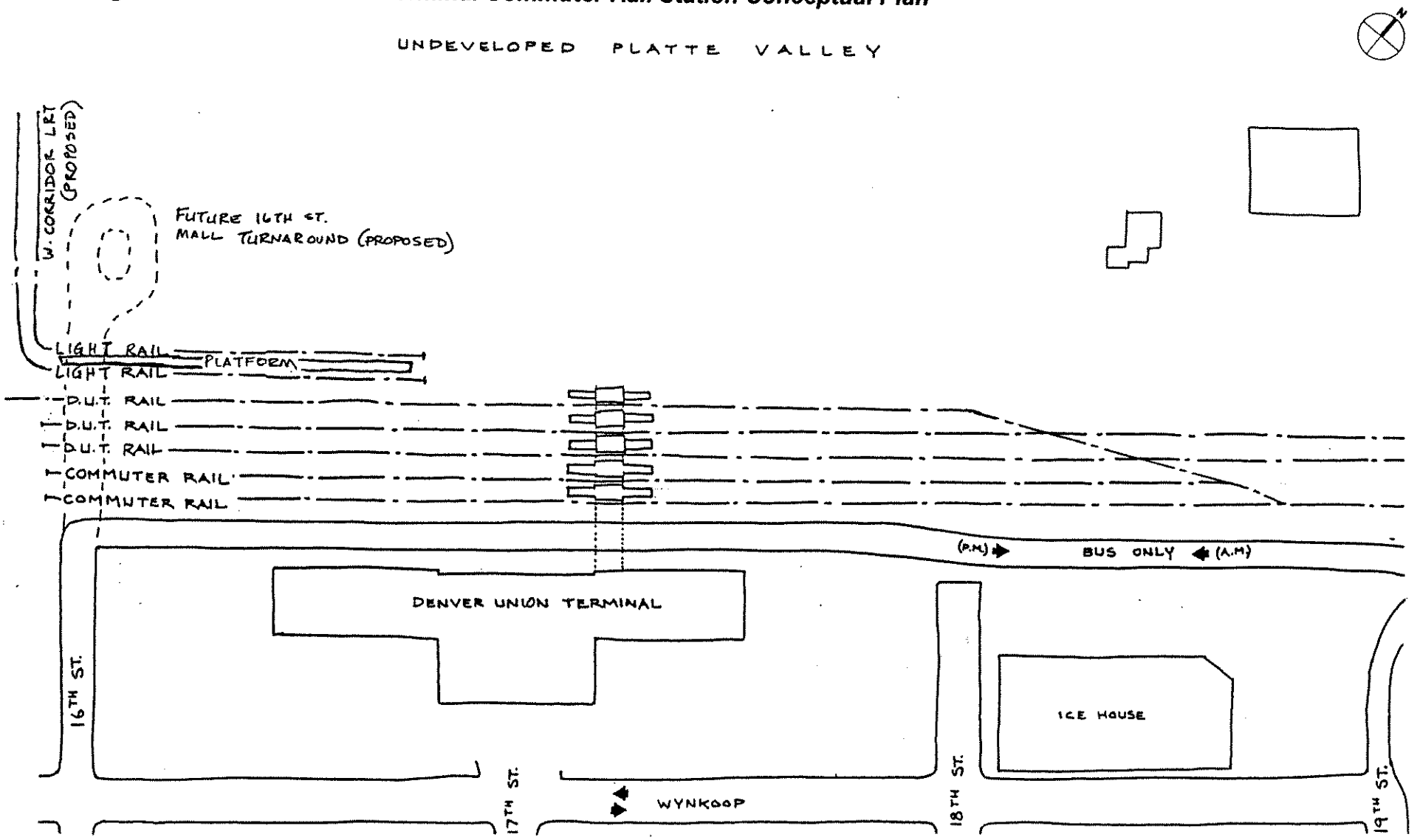


Figure 5-5
40th St./40th Ave. Commuter Rail Station Conceptual Plan

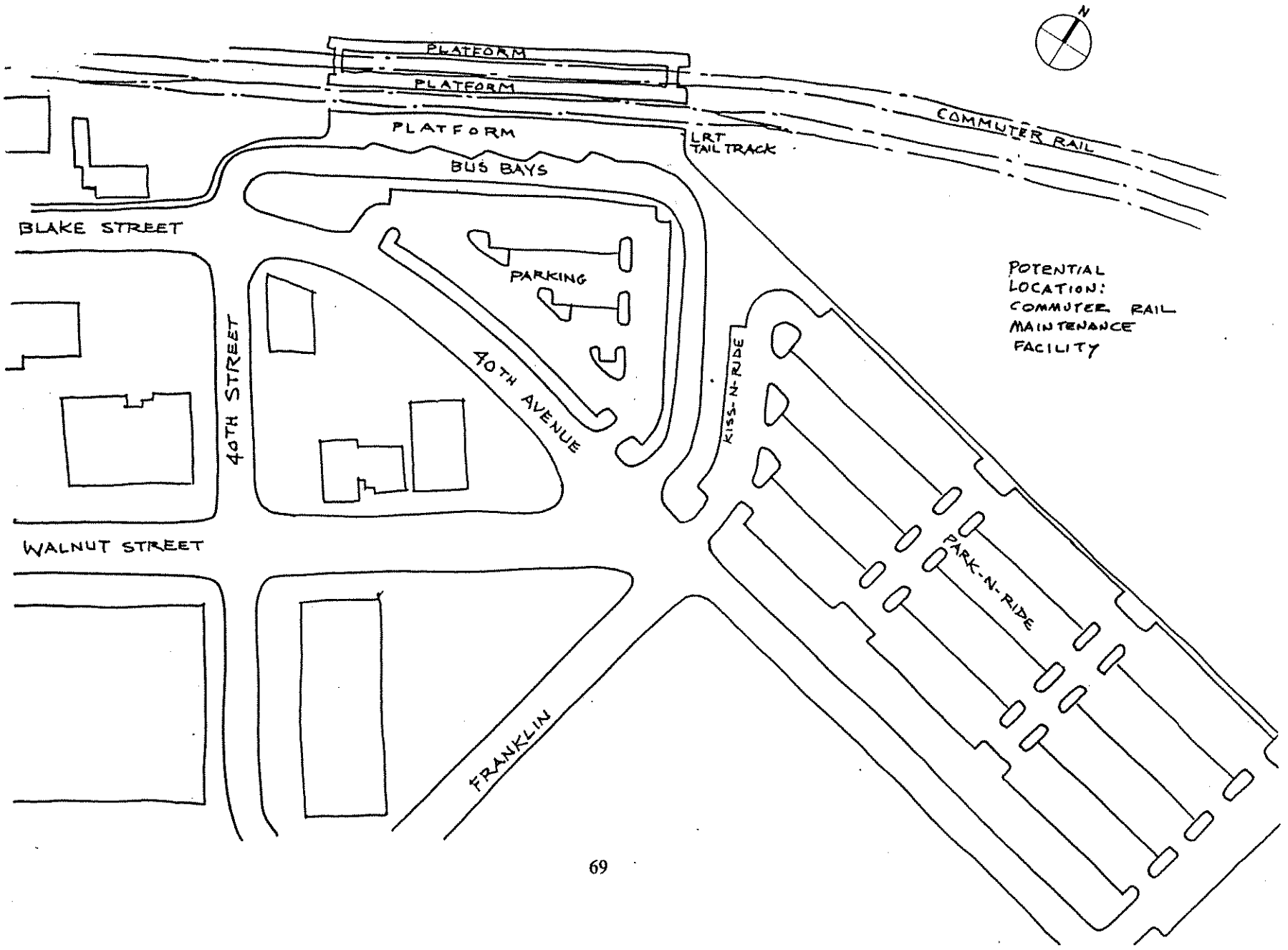


Figure 5-6: Stapleton Commuter Rail Station Conceptual Plan

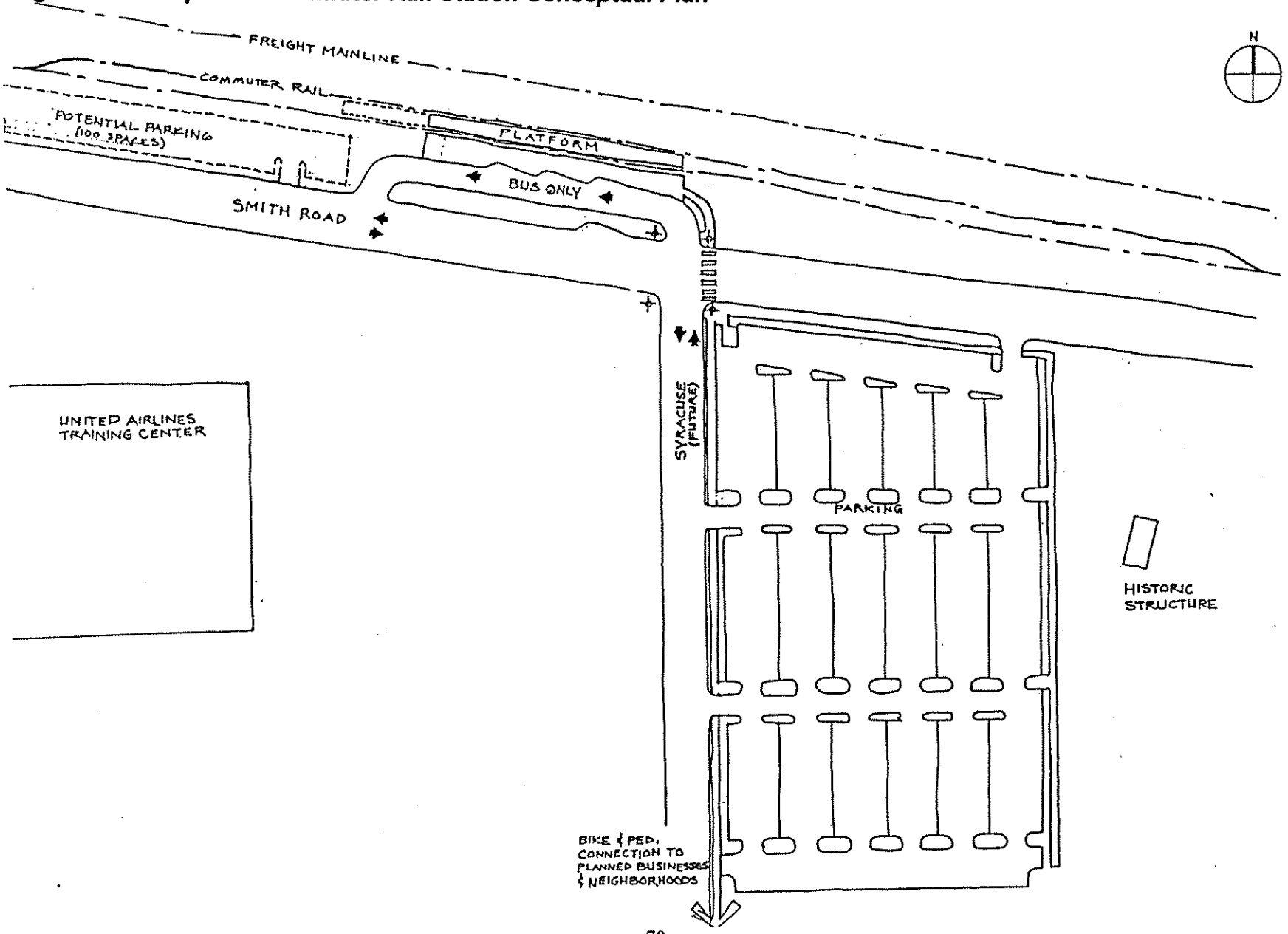


Figure 5-7: Gateway Commuter Rail Station Conceptual Plan

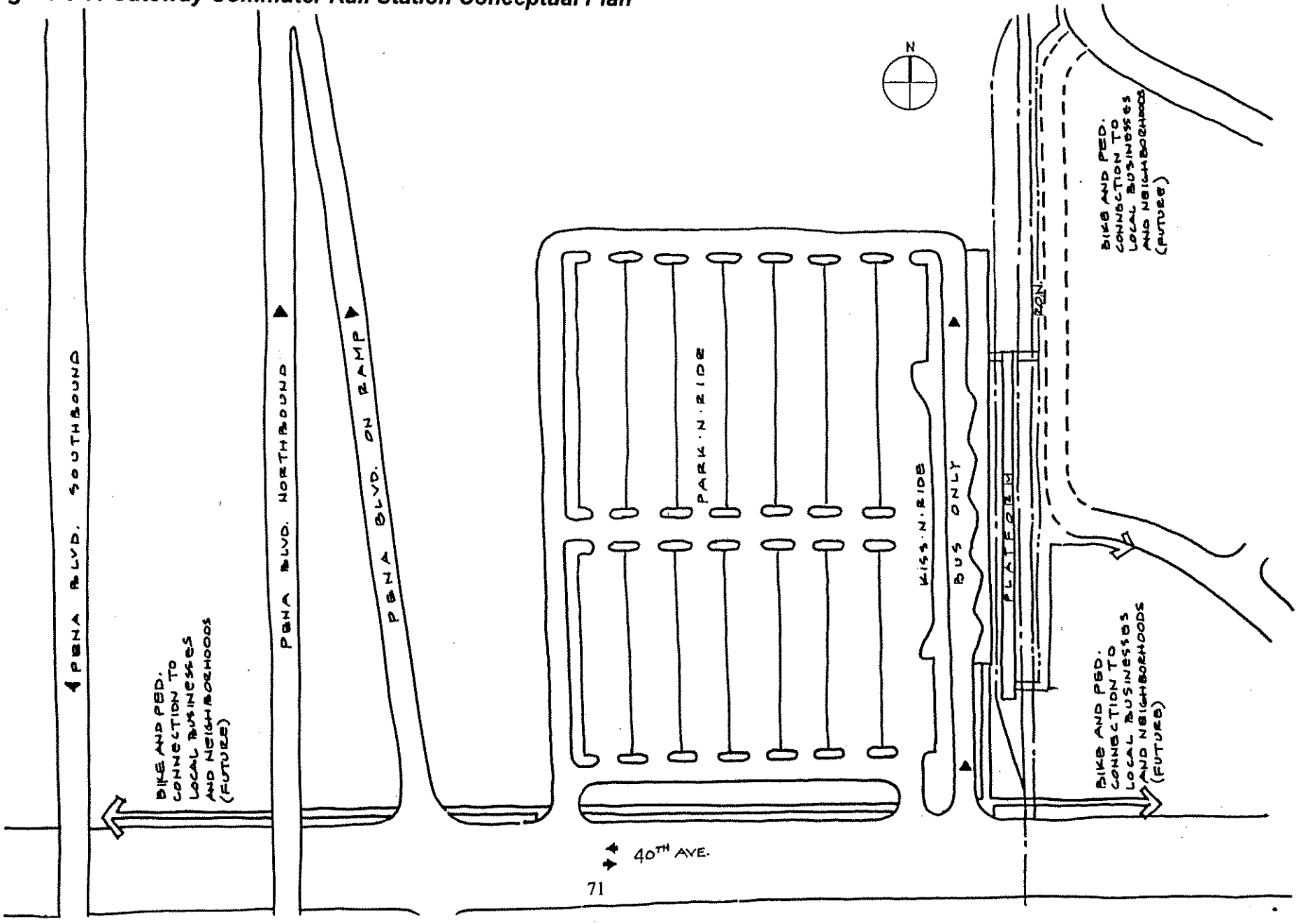
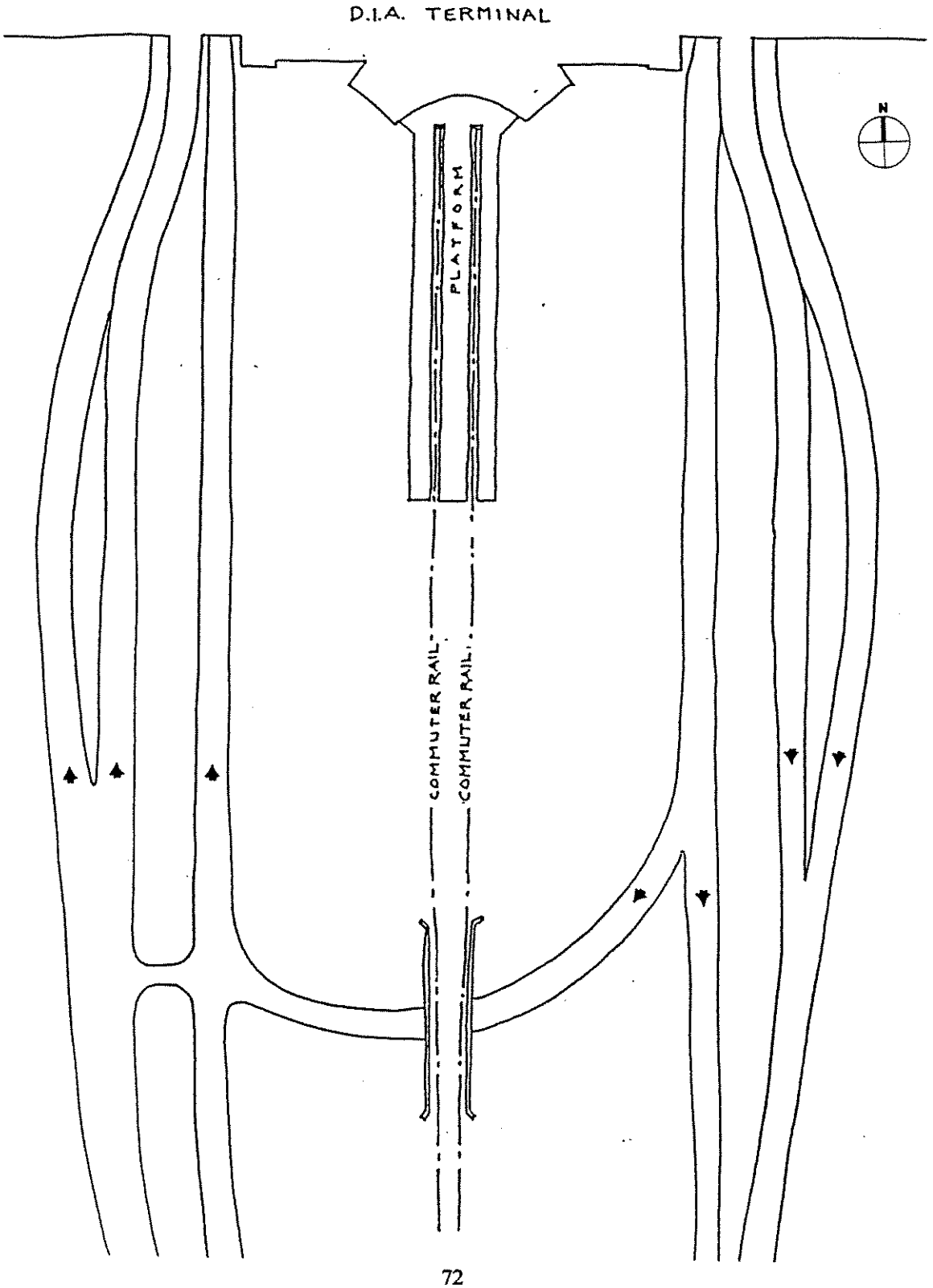


Figure 5-8: DIA Commuter Rail Station Conceptual Plan



Coors Field Special Platform

For use during Colorado Rockies baseball games, a special platform would be located just east of the 20th St./Downtown Express HOV lanes, providing a direct pedestrian connection to the baseball stadium to the south (see **Figure 5-9**). No parking or other additional amenities would be provided at this site.

Future I-225 Station

Recognition is made of the need to accommodate a linkage to a future I-225 rapid transit line. A station would be anticipated at the junction of the East Corridor and I-225 lines; details would be developed during the planning stages for the I-225 line.

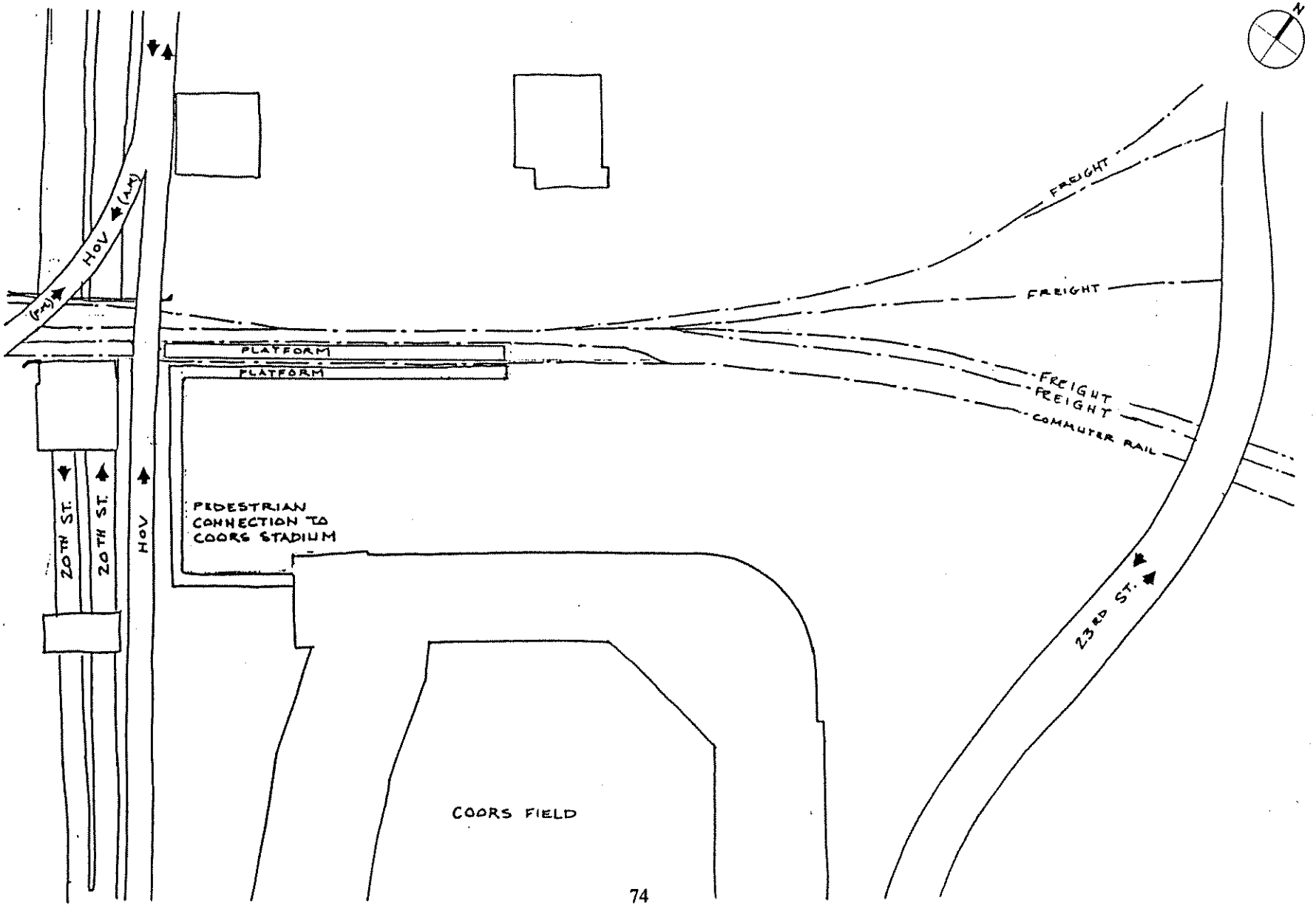
Commuter Rail Maintenance Facility

Train storage and maintenance facilities for the commuter rail alternative would be provided at the existing UP intermodal yard site near Josephine St. The UP claims that to accommodate commuter rail, the intermodal yard would need to be acquired, with operations relocated elsewhere. This site encompasses approximately 60 acres, and is well situated to serve train storage and maintenance functions.

The train storage and maintenance facilities for the commuter rail alternative would include the following features at a minimum:

- Storage tracks for the full length of all of the train sets and the spare cars;
- Supplemental trackage for train switching and other movements;
- Road access to DMUs for fueling, sanding, and servicing;
- Train washing and interior cleaning facilities;
- A train maintenance shop with one train-length pit track and one floor-level track (for jacking cars), overhead bridge crane, parts storage room, major component handling area (for wheels, traction motors, etc.), offices, restrooms, lunchroom, and conference/training room. If not provided initially, space should be allocated for the future installation of a drop table and a wheel truing machine;
- A maintenance-of-way building with parts storage room, portable tools and equipment room, electronic component room, open floor work space, overhead or jib crane, offices, restrooms, and conference/training room;
- Outdoor space for maintenance-of-way vehicles, track machines, and storage of bulky items such as rail, ties, ballast, etc.; and
- Site lighting, fencing, fire protection system, access roadways and employee parking.

Figure 5-9
Coors Field Commuter Rail Special Platform Conceptual Plan



5.2.4 Light Rail Physical Characteristics

Central Corridor LRT Extension

To provide direct, cross-platform connectivity between East Corridor commuter rail and RTD's existing LRT line (and any future line that connects to the Central Corridor), it is proposed that the LRT line be extended north from its current terminus to the UPRR alignment. The line would run along the west side of Downing Street north from the existing terminal station at 30th. At 36th St., the proposed alignment would jog northwest for approximately one block, to attain the Walnut St. railroad spur alignment. It would follow that spur alignment north to intersect the UP rail alignment just south of 38th St., and continue east two blocks to a station at 40th St./40th Ave. This extension would be built at-grade, requiring at-grade crossings of streets between 30th Ave. and Blake St. The line would cross 38th St. on a new structure, which also would accommodate commuter rail tracks.

Currently, the northeast segment of the Central Corridor LRT line has only a single track on Welton St. north of 19th St. While this configuration provides operating challenges, it is viewed as tolerable because it is the end-of-line segment. The extension would be built as a single-track alignment as well. **Figure 5-10** shows the LRT extended alignment, and **Figure 5-11** shows a typical cross-section for the LRT extension.

Light Rail Extension Station

A new LRT station is recommended along Downing St. just west of the 33rd Ave. intersection (see **Figure 5-12**). Essentially similar to the current stations along Welton St., it would consist of a single platform serving the single-track LRT line. While bicycle and pedestrian connections would be constructed to the surrounding neighborhood, no parking would be provided at this station.

5.2.5. Commuter Rail Operational Characteristics

Rail Vehicle Technology

The suggested commuter rail vehicle technology used as an example in this report for costing and other purposes is a conventional diesel multiple unit (DMU) vehicle, such as the Siemens-Duewag VT610 shown in **Figure 5-13.** The VT610 is a proposed Federal Railway Administration-compliant DMU evolved from the VT628 series, which is much in use in Europe and other places in the world outside of the U.S. **Table 5-3** summarizes typical desired commuter rail train performance characteristics for the suggested vehicle, although specific applications in the East Corridor may result in slightly different operating characteristics. The VT610's acceleration and deceleration rates, maximum speeds, and station dwell times resemble those for conventional diesel-electric locomotives, but the VT610 car is being designed to travel on tighter curves and steeper grades. The VT610 cars should be able to seat 85 passengers.

Figure 5-10
Extension of LRT along Downing

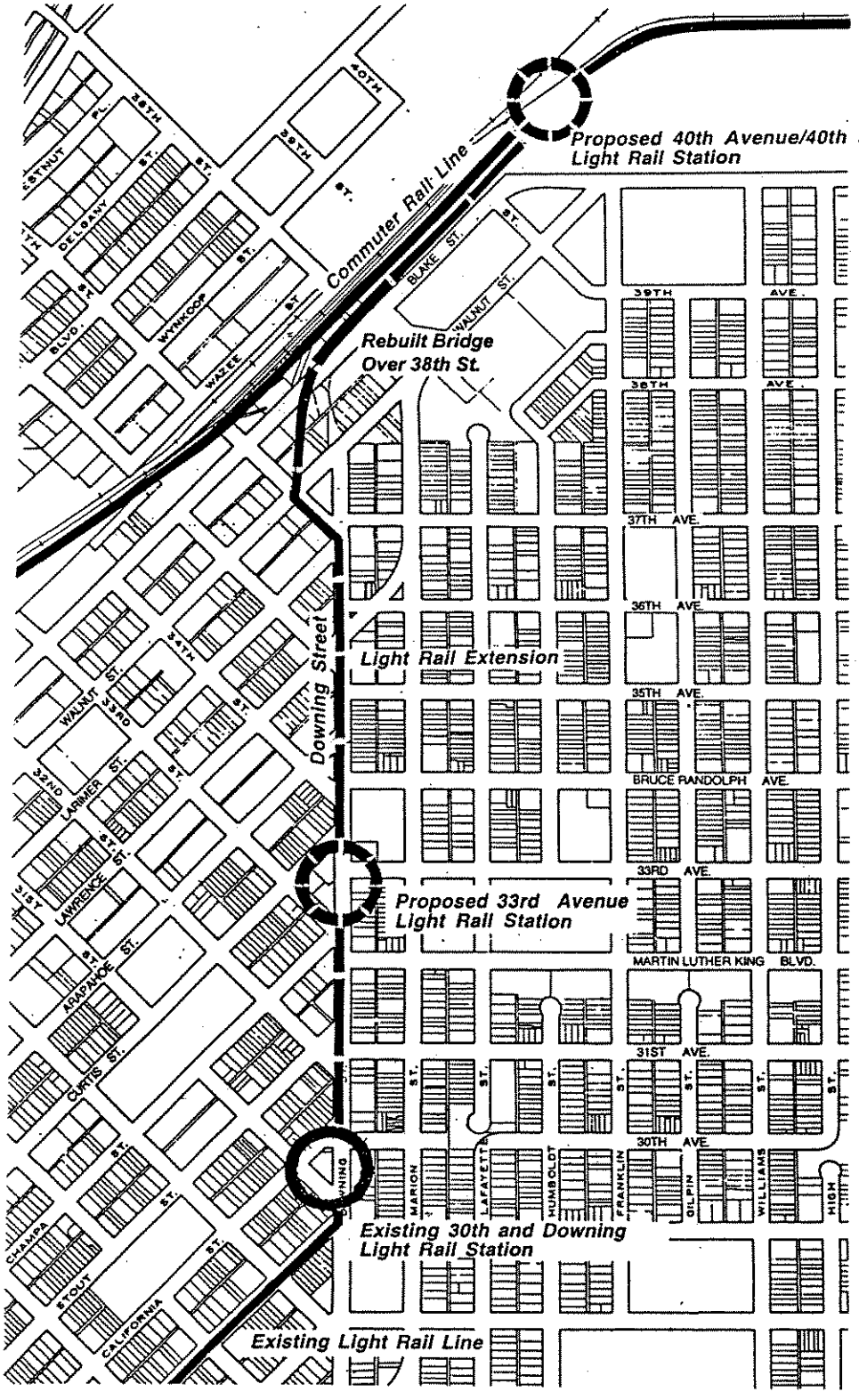


Figure 5-11: Cross-Section of Downing Extension LRT
(view looking north on Downing)

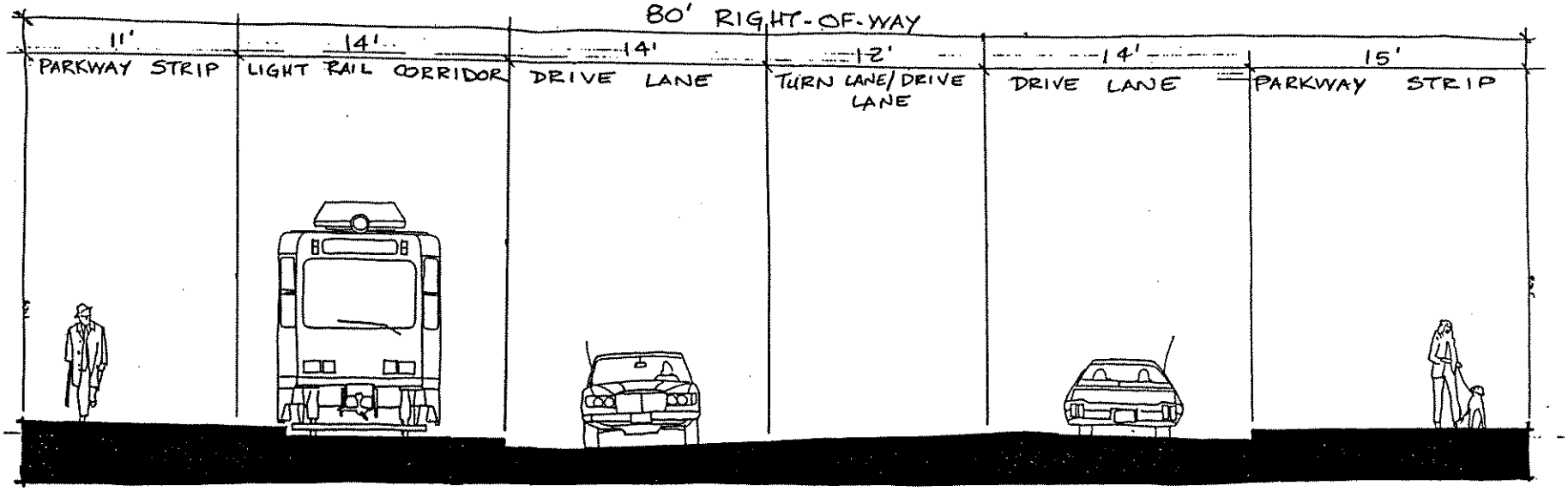


Figure 5-12: Downing Extension LRT Station Conceptual Plan

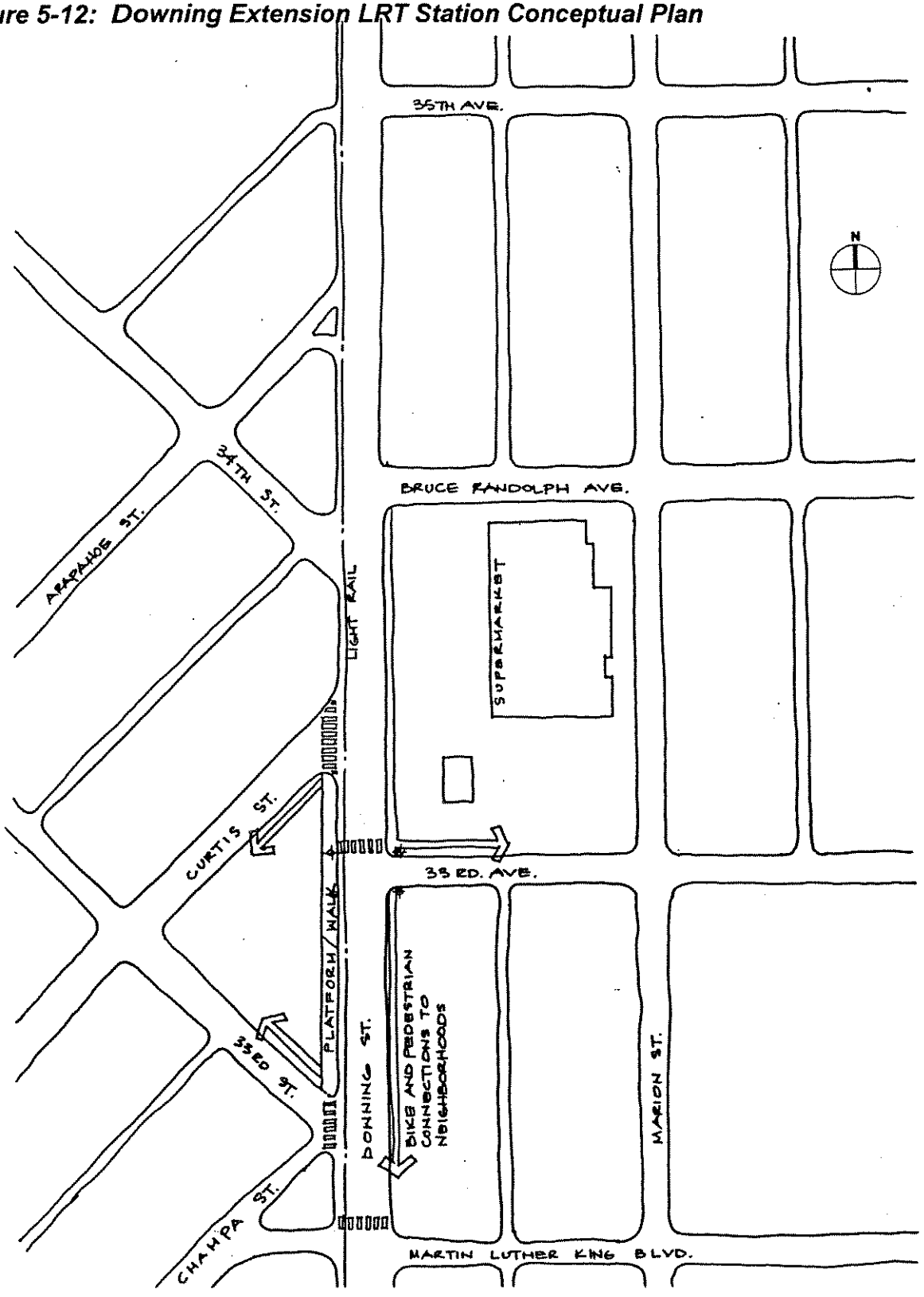


Figure 5-13
Siemens-Duewag VT610 (Example Commuter Rail Vehicle)

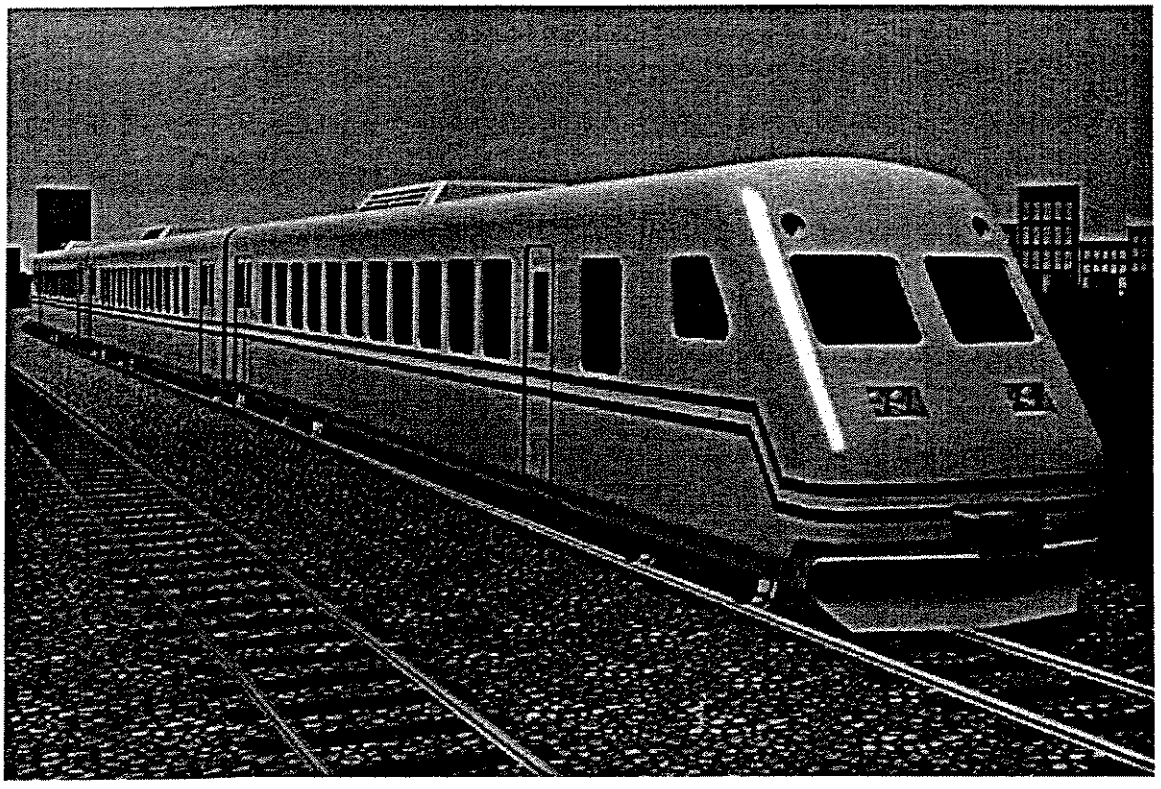


Table 5-3
Desired Commuter Rail Vehicle Performance Characteristics

Operating Characteristic	DMU Train VT610
Acceleration rate	1.0 MPH/sec.
Deceleration rate	1.0 MPH/sec.
Maximum speed	80 MPH*
Station dwell time (avg.)	90 sec.
Minimum curve radius	300 ft.**
Maximum grade	3.5%**

* FRA limitation
** Recommended, but can be exceeded at slow speeds.

The trains will be heated and air conditioned, well-lighted, will have a public address system for station and other announcements, and will have automatic doors. The trains would provide low-level boarding in compliance with the Americans with Disabilities Act (a mini-platform and ramp or other suitable method would be provided), would have ample space inside the cars to store luggage, and would operate with low-emission, fuel-efficient locomotive engines. The trains would need to be compliant with the structural and safety standards for U.S. railroad passenger equipment in order to operate in right-of-way shared with freight trains. The VT610 is being designed to do so.

Systems Technology

The systems technology for the commuter rail alternative includes railroad track; signaling; grade crossing warning devices; train radio, telephone, and public address communications; environmental and security systems for stations and maintenance facilities; and fare collection equipment. A railroad signaling system will be provided for the operation of both passenger and local freight trains in accordance with FRA regulations. Centralized Traffic Control (CTC) with bi-directional signals will be provided for the main line and sidings of the commuter rail route. The commuter rail signaling system will be compatible with the existing UP Computer Aided Dispatching (CAD) System. The dispatching of passenger trains will likely be done from a local dispatching center located at a site such as the vacant tower at DUT.

All of the existing grade crossings will be upgraded and equipped with gates, train motion detectors, and state-of-the-art circuitry and technology. The train motion detectors trigger the crossing lights, bells, and gates based upon the speed of an approaching train. This technology provides consistent warning and gate down-time where train speeds vary from slow freight to fast passenger trains. The upgrading of grade crossings will be in accordance with the requirements of the Colorado Public Utilities Commission.

Communications for the commuter rail service will include train radio with channels for both UP and commuter rail operations, telephone, and public address for announcements at stations.

Water and soil treatment, air pollution, noise mitigation, and other applicable environmental systems will be provided wherever necessary. Fencing, alarms, and other security features will be provided as appropriate for stations, train storage and maintenance facilities, and any other such fixed plant locations of the commuter rail system.

Fare collection equipment would be provided at stations, including ticket vending machines, change machines, ticket validators, and other such devices as appropriate.

Commuter Rail Operations

Commuter trains are proposed to operate every 20 minutes from 6 a.m. to 12 midnight, every day of the year, with some limited serving beginning at 4 a.m. Using

VT610 technology, travel time (without transfers) between DUT and DIA would be approximately 35 minutes, including 90-second average station stops at each of the intermediate stations at 40th St./40th Ave., Stapleton, and Gateway. This equates to an average speed of about 40 MPH for the alignment. Travel time, average speed, and maximum speed on key segments are estimated to be:

- DUT to 40th St./40th Ave. (including dwell at 40th St./40th Ave.): 5 minutes, with 33 MPH average speed and 40 MPH maximum speed;
- 40th St./40th Ave. to Stapleton (including dwell at Stapleton): 7 minutes, with 39 MPH average speed and 45 MPH maximum speed;
- Stapleton to Gateway Station (including dwell at Gateway): 10 minutes, with 47 MPH average speed and 60 MPH maximum speed; and
- Gateway to DIA: 12 minutes, with 52 MPH average speed and 80 MPH maximum speed.

5.2.6. Light Rail Operational Characteristics

Vehicles used on the light rail extension on Downing would be the same as those currently operated on the Central Corridor line. The light rail extension to 40th St./40th Ave. would operate at twelve-minute peak headways and fifteen-minute off-peak headways, with trains originating from Mineral Ave. on the Southwest Corridor LRT line. Travel time from 30th/Downing to 40th St./40th Ave. is estimated to be approximately six minutes.

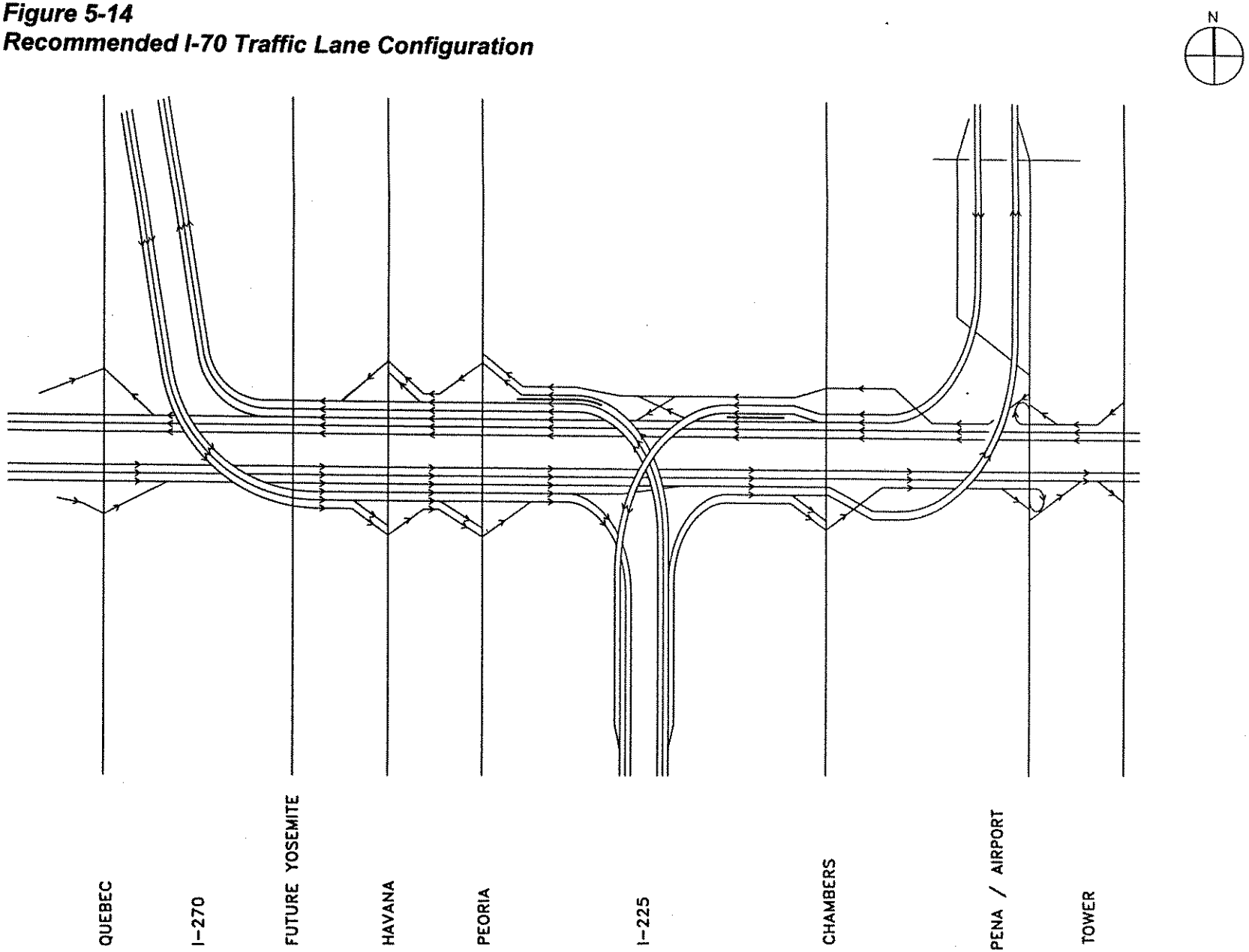
5.2.7 Ancillary Improvements

RTD's 16th Street Mall shuttle currently terminates at the Market St. station, some three blocks east of DUT. If commuter rail is to provide reasonable service to the CBD, the mall shuttle must be extended to DUT. The feasibility of this extension has been studied by both RTD and Denver, and is recognized in Denver's long-range plans. A proposed mall shuttle turnaround location has been depicted at the end of 16th St., as shown earlier in **Figure 5-4**. The details of operating mall shuttles will need to be specified during subsequent study, but preliminarily it is estimated that an additional six shuttle vehicles will be required to maintain a 70-second shuttle headway.

5.3 Freeway Components

Highway capacity is increased on the most highly congested segment of the East Corridor, between I-270 and I-225, in the recommended investment package. I-70 would be reconstructed and widened to five through lanes in each direction in this "inner beltway" segment. I-70 also would be widened in each direction between I-225 and Peña Blvd. to transition this additional laneage. **Figure 5-14** shows the proposed lane configuration for I-70 between I-270 and Peña Blvd.

Figure 5-14
Recommended I-70 Traffic Lane Configuration



Other major freeway elements in this package include:

- The viaduct section of I-70 between Brighton Blvd. and Colorado Blvd. would be rebuilt and widened enough to include standard-width inside and outside shoulders. During the Environmental Impact Statement (EIS) process, widening to accommodate additional lanes may be considered (see Section 4.5.4). (The estimated $100 million cost of rebuilding the viaduct is not counted against the East Corridor budget. "Other" funds would be used to construct this project)

- The York/Josephine interchange would be eliminated (also subject to review during the viaduct EIS process).

- The Vasquez/Steele interchange would be rebuilt concurrent with viaduct reconstruction.

- The Colorado Blvd. interchange would be rebuilt as a substandard diamond, but accommodating all traffic movements. The Colorado structure would be rebuilt.

- The Havana St. interchange would be rebuilt as a diamond (with a new bridge for a relocated railroad spur).

- The Peoria St. structure would be rebuilt and widened to accommodate new I-70 through lanes and additional Peoria St. turn lanes.

- The Yosemite St. (Air Cargo) structure would be rebuilt to accommodate I-70 widening.

- The I-70 bridges over Sand Creek would be rebuilt and widened to accommodate shoulders and enhanced acceleration/ deceleration lanes to/from the east.

- Continuous acceleration/deceleration lanes would be provided between interchanges in the areas where I-70 is widened (unless rendered unnecessary by other elements such as collector/ distributor roads or "outer" lanes).

Figure 5-15 depicts the freeway components of the recommended investment package.

Programmed improvements for I-70 are assumed to be constructed, and are not included in the Corridor budget. These improvements include:

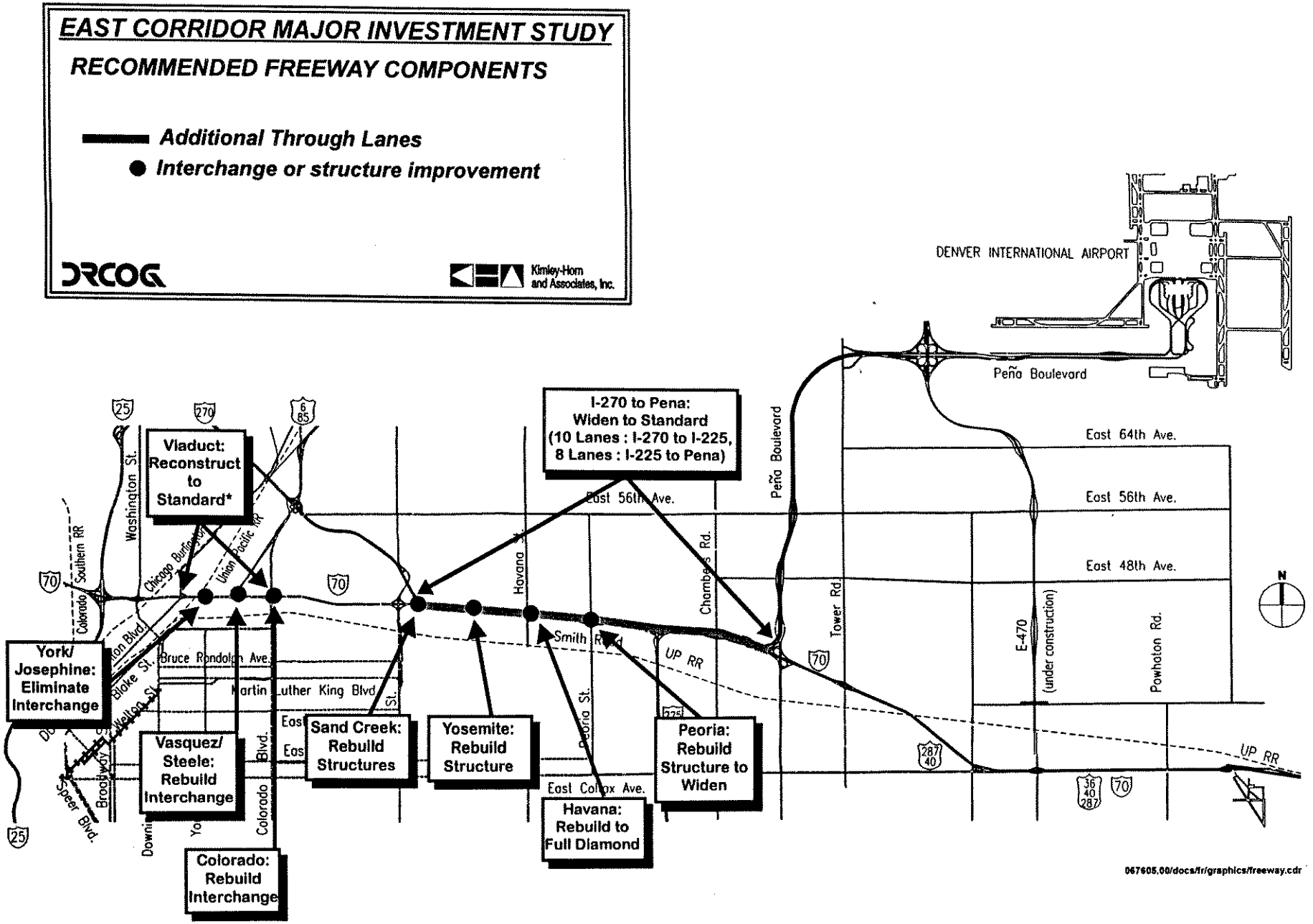
- Reconstructing and widening I-70 to eight through lanes between Washington and Brighton; and

- Reconstructing the I-225/I-70 interchange. This project will complete right-side entrances and exits with the I-70 mainline straight through the center. The new northbound-to-westbound flyover ramp will have three lanes: two "through" lanes to I-70 and an exit ramp lane to Peoria.

In addition, the programmed improvement replacing the Broadway viaduct with a four-lane underpass is assumed to be constructed and similarly not included in the Corridor budget.

Previous analysis during the MIS process projected heavy congestion on Peña Blvd.

Figure 5-15



* Widening to accommodate additional lanes may be considered during environmental process

east of E-470. Minimal construction would be needed to add one lane in each direction on this segment. Since this would only serve DIA traffic, it is expected that the airport would pursue this improvement when conditions warrant it.

I-70 would remain at the existing six-through-lane cross-section from Brighton Blvd. to I-270. Peña Blvd. would remain at four through lanes from I-70 to E-470.

5.4 Transportation Management Components

The Transportation Management elements of this package are a collection of smaller, mutually supportive projects intended to improve operations and modify or reduce the demand for travel in the East Corridor. The Transportation Management elements are divided into two major types of improvements: *supply-related* or Transportation System Management (TSM) projects, and *demand-related* or Transportation Demand Management (TDM) strategies. TSM projects largely attempt to improve the efficiency of the system and "squeeze" more capacity from it. TSM components in the East Corridor include arterial, bus, Intelligent Transportation Systems, and bicycle/pedestrian facility improvements. TDM strategies include various actions designed to reduce trip making or modify travel behavior to reduce congestion.

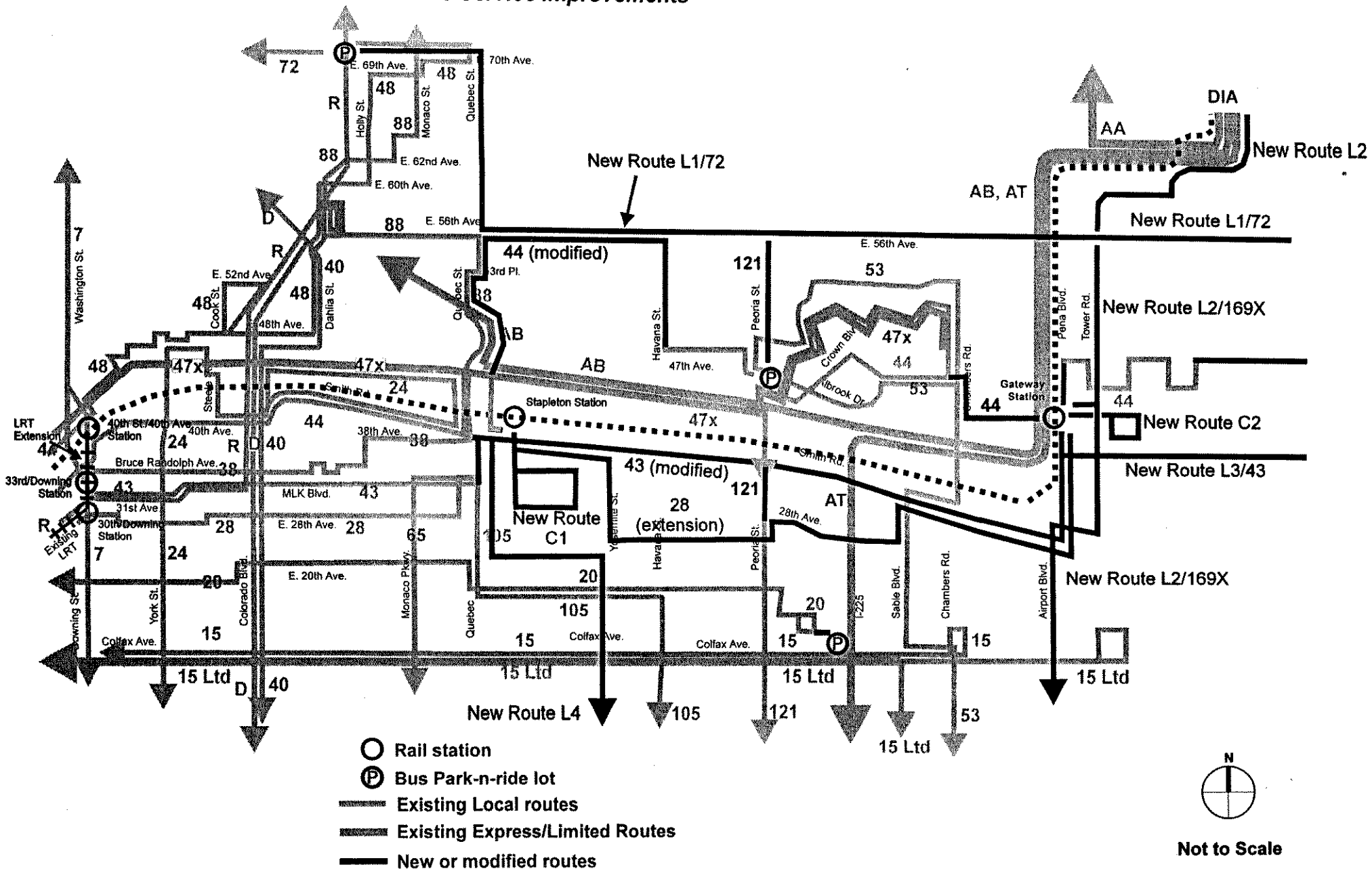
5.4.1 Bus Service Improvements

Bus services in the East Corridor would be enhanced by adding new routes to serve developing areas, configuring some new and existing routes to feed commuter rail stations, and truncating or eliminating existing routes that duplicate commuter rail service. These service improvements address mobility needs for many of the transit-dependent persons in the Corridor.

Figure 5-16 illustrates proposed bus service changes in the corridor, which include:

- Adding new local routes L1, L2, and L3 to serve future development in the eastern parts of the corridor. L2 would be interlined with the 169X and provide all-day local service along Airport Blvd. and Tower Rd. between DIA and south Aurora. L2, L3, and 169X would feed the Gateway commuter rail station.
- Adding new local route L4 between the Denver Tech Center and the Stapleton commuter rail station.
- Adding a C1 circulator route that serves the Stapleton site from the Stapleton commuter rail station.
- Adding a C2 circulator route that serves the Gateway development site from the Gateway station.
- Diverting route 44 to serve the Gateway station (providing a collector/distributor function between the Gateway, Montbello, and Green Valley Ranch areas), re-routing it from I-70 to E 56th Ave./Quebec St., and modifying the route to also serve the Stapleton and 40th St./40th Ave. commuter rail stations.

Figure 5-16
Recommended East Corridor Bus Service Improvements



- Extending Routes 28 and 43 through the Stapleton site and having them link the Gateway and Stapleton commuter rail stations.

- Modifying all routes that currently stop at the Stapleton park-n-Ride lot to serve the Stapleton commuter rail station.

- Modifying Route 121 to serve the Montbello park-n-Ride lot and continue north to 56th Ave. via Peoria St.

- Diverting skyRide route AB so that it no longer stops at Stapleton.

- Eliminating skyRide routes AS (between Stapleton and DIA), and AF (between Cold Spring and DIA). The Cold Spring to downtown portion of route AF would be retained as an express route to DUT.

- Eliminating the portion of route 47X east of Chambers Rd.

- Modifying routes 7, 44, and 48 so they serve the 40th St./40th Ave. commuter rail station.

Headways on new and existing routes that serve commuter rail stations would be adjusted to match the 20-minute rail headways on a timed-transfer basis where possible.

5.4.2 Arterial Improvements

East 56th is currently two lanes wide east of Quebec St. Widening 56th to four through lanes and to current arterial standards from Quebec to the vicinity of the employee parking lot south of DIA would establish the roadway as a primary east-west arterial and an important alternate route for DIA-bound traffic. Further west, reconstruction of the 56th Ave./I-270 overpass would be needed to accommodate four through lanes of traffic on 56th Ave. The responsibility for widening E. 56th Ave. lies with the local jurisdictions that it crosses, but since 56th Ave. is a principal arterial in the Regional Transportation Plan, improvements would be eligible for federal funding through the Transportation Improvement Program (TIP) process.

5.4.3 Intelligent Transportation System (ITS) Improvements

ITS is the application of "advanced" technologies to address transportation mobility and safety issues. In the Denver region ITS is seen as a way to:

- make current facilities operate more efficiently;
- make the system operate more reliably;
- enhance transit to effect longer-term changes in travel behavior; and
- provide reliable real-time transportation condition information to enable "better" short-term mode/time/route decisions.

To make ITS a reality, numerous institutional and operational obstacles must be overcome, and a substantial amount of infrastructure must be deployed. Intelligent transportation infrastructure specific to the East Corridor and assumed in this package includes:

- Freeway incident management:
  - continue and enhance operation of Mile High Courtesy Patrol
  - develop incident diversion plans
  - install video surveillance cameras at select/critical corridor locations.
- Freeway Management:
  - provide fiber-optic communications along I-70;
  - install mainline and ramp detection;
  - examine the feasibility of installing ramp meters at the westbound on-ramps at Tower, Airport, Chambers, Quebec, Dahlia, and Colorado. (Havana and Peoria are already metered). Vasquez Blvd. is problematic due to grades.
  - install highway advisory radio in the Corridor; and
  - install permanent variable message signs in the Corridor.
- Arterial Management:
  - install traffic signal systems on all principal arterials in the corridor and key freeway diversion routes (e.g. Smith Rd.). (Segments of Peoria, Quebec, and Colfax currently have systems operating);
  - link ramp meters to arterial signal system at key corridor interchanges; and
  - link signal systems to active rail crossing devices at key crossings.
- Transit Enhancement:
  - install security cameras at corridor park-n-Ride lots and stations;
  - develop real-time transit status information and display on-line and at kiosks in stations, at DIA, in the CBD, and at key bus stops along Colfax; and
  - in concert with installation of a signal system, implement bus priority or partial priority treatment along Colfax.
- Traveler information:
  - data gathering and corridor-specific information disseminating devices are noted above. Data assemblage and assimilation and information development functions are regional in nature, not corridor-specific.

5.4.4 Bicycle/Pedestrian Improvements

The recommended investment incorporates implementation of the Pedestrian and Bicycle Element of the Regional Transportation Plan (RTP). This plan provides guidance for the provision of bicycle and pedestrian facilities that function as part of an integrated metropolitan transportation system within the Denver region. The recommended investment also incorporates facilities to link commuter rail stations and park-n-Ride lots in the East Corridor to the regional bicycle/pedestrian system.

5.4.5 *Transportation Demand Management (TDM) Components*

TDM is a term used to describe a category of strategies designed to improve mobility by reducing and/or modifying travel demand. TDM actions could be implemented within specific employment areas by organizations created specifically to address travel demand management issues, such as Transportation Management Organizations (TMOs), or by agencies with other roles that add these responsibilities.

TDM actions that potentially could be undertaken in the East Corridor include:

- Advancing the conformity measures adopted in the update to the 2015 Regional Transportation Plan, including:
  - encouraging compressed work weeks;
  - enhanced carpool/vanpool marketing;
  - encouraging telecommuting; and
  - restricting parking at major employment centers.
- Implementing additional transportation demand management actions, such as:
  - enhanced marketing of transit (particularly to air passengers);
  - supporting/sponsoring feeder bus services (shuttles or circulators); and
  - subsidizing transit passes (particularly among employees at DIA, Stapleton, Gateway, and downtown locations).

5.5 Recommended Corridor Investment Performance

The recommended corridor investment was analyzed according to the same criteria used during the evaluation of the six detailed level alternatives and during the evaluation of the two package alternatives (see Chapter 4). The recommended corridor investment closely resembles the "Package A" alternative that was evaluated in Chapter 4, but with fewer highway widening components. Accordingly, the performance measures subsequently presented in **Tables 5-4 through 5-7** are similar to those for Package A, but with more congestion and fewer daily users. The recommended corridor investment addresses most of the corridor needs as described in Chapter 3, but not all.

5.5.1 *Mobility Benefits*

Table 5-4 includes key measures for projected year 2020 mobility benefits attributable to the recommended corridor investment. The investment would improve conditions over No Capacity Increase or "Base Case" conditions for each criterion, except for increased congestion on the I-70 viaduct between Brighton and Colorado. The investment would reduce projected weekday vehicle miles of travel and weekday person hours of delay, and would increase projected weekday transit ridership by nearly 9,000 persons. Of the estimated 108,800 projected weekday users of the major elements in the recommended corridor investment, about 95,900 would be highway users and the remaining 12,900 would be rail users.

Table 5-4
Recommended Corridor Investment Mobility Benefits (Estimates for Year 2020, Average Weekday)

Criteria	Base Case[1]	Recommended Corridor Investment
Regional Transportation Measures (Daily)		
Vehicle Miles Traveled	73,695,000	73,654,000
Change in Vehicle Miles Traveled	*NA*	*-41,000*
Person-Hours of Delay	659,300	602,100
Change in Person-Hours of Delay	*NA*	*-57,200*
Linked Transit Trips	231,300	240,100
Change in Linked Transit Trips	*NA*	*+8,800*
Corridor Measures		
Users* Per Day	NA	108,800
Investment* Capacity per Direction (persons per hour)		
- west of Vasquez/Steele	NA	765
- east of I-270	NA	6,365
- north of 40th Ave.	NA	765
Investment* Use (persons per hour) (pk hr/pk dir)		
- west of Vasquez/Steele	NA	550
- east of I-270	NA	5,900
- north of 40th Ave.	NA	700
Freeway volumes (all day, both directions)		
- west of Vasquez/Steele	143,000	148,000
- east of I-270	198,000	225,000
- north of 40th Ave.	110,000	113,000
Freeway volume-to-capacity ratio (pk hr/pk dir)		
- west of Vasquez/Steele	1.17	1.21
- east of I-270	1.39	1.09
- north of 40th Ave.	1.12	1.12
Travel time: auto/HOV/transit *(headway)* from CBD to DIA in...		
- A.M. peak hour	37/37/46 *(60)*	33/33/40 *(20)*
- P.M. peak hour	46/46/57 *(60)*	39/39/40 *(20)*
Transit Travel Time Reliability	Poor	Very Good

[1] Base refers to Year 2020 conditions without increased capacity in the corridor.

NA = Not applicable.

* Statistics reported for major elements of the recommended corridor investment (commuter rail and widening of critical I-70 links)

The largest increase in person carrying capacity would be between I-270 and I-225, where commuter rail and four additional general traffic lanes would accommodate a total of 6,365 more persons per hour, per direction. Projected use of the additional capacity provided would approach 70% to 90% during the peak-hour, peak-direction.

Morning and afternoon peak-hour travel times between DUT and DIA would improve for all modes. The greatest improvement would be for transit riders traveling between DUT and DIA during the afternoon peak hour, who would save about 17 minutes of travel time with the recommended corridor investment. This time savings, coupled with the increased reliability of commuter rail (which is not influenced by highway congestion), would provide a substantial benefit for a key travel market in the East Corridor. Potential development of DUT as a major intermodal hub could make this travel market even larger.

5.5.2 Capital and Operating/Maintenance Costs

Table 5-5 displays estimated capital and operating/maintenance costs for the different components of the recommended corridor investment. Commuter rail, which constitutes more than 60% of the Corridor's investment costs, is itemized in more detail than other components.

5.5.3 Cost-Effectiveness

Table 5-6 includes measures of cost-effectiveness according to three key mobility measures. Users include highway and rail passengers using the additional capacity provided by the recommended corridor investment.

5.5.4 Community and Natural Resource Impacts

Table 5-7 shows the anticipated impacts to community and natural resources in the East Corridor that would result from implementing the recommended corridor investment. There would be some displacement of residences and businesses required to widen the I-70 viaduct between Brighton and Colorado to provide shoulders, and to reconstruct the Vasquez interchange. It is estimated that this would directly displace two residences and two businesses (the Pilot complex and Stop 'n' Shop/ Husky). The Colonial Manor Motel also would be impacted, possibly requiring acquisition of a portion of the motel, and parking for the Denver Rescue Mission would be impacted. Mitigation of neighborhood concerns may result in some additional residential displacements. The details of this will need to be addressed during the EIS process.

Reconstruction of the I-70 viaduct between Brighton and Colorado would encroach upon the Swansea Elementary School playground area, but to a lesser degree than would a widening of the viaduct for additional traffic lanes. **Figure 5-17** illustrates the potential encroachment that would result from the reconstruction. Playground area lost could be compensated by street vacation or acquisition of nearby property. These details would be addressed during the EIS.

Table 5-5
Recommended Corridor Investment Costs

Capital Costs	Millions of 1995 Dollars
Commuter Rail	
- Right-of-Way	$25.0
- Removals and Earthwork	$10.6
- Trackwork and Signals	$44.7
- Structures, Walls, Culverts	$52.0
- Stations	$5.6
- DMU Vehicles	$42.3
- Maintenance Facility (includes ROW)	$26.3
- Misc. Design Features (1)	$20.7
- Mobilization, Contingencies, Other Costs	$88.7
Commuter Rail Subtotal	*$315.9*
Light Rail	
- Trackwork, Electrification, Signals	$5.1
- Station	$2.2
- Misc. Design Features (1)	$2.7
- Mobilization, Contingencies, Other Costs	$4.0
Light Rail Subtotal	*$14.0*
Freeway Widening (2) (3)	*$37.7*
Transportation Management Elements: (3)	
- E.56th Ave. Widening	$44.7
- Additional buses	$10.0
- Intelligent Transportation Systems (ITS)	$15.0
- Bicycle & Pedestrian facilities	$3.0
Transportation Management Subtotal	*$72.7*
Total Capital Cost	***$440.3***
Annualized Total Capital Cost	***$35.2***
Annual Operating and Maintenance Costs	
Commuter Rail	$18.5
Light Rail	$0.3
Bus	$8.9
Highway and Arterial Maintenance	$1.0
Intelligent Transportation Systems (ITS)	$3.0
Total Annual Operating Cost	***$31.7***
Total Annualized Cost	**$66.9**

(1) Includes drainage, utility relocation, noise and environmental abatement/mitigation, signing and striping, construction traffic control, and urban design/landscaping.
(2) Does not include estimated $100 million cost of reconstructing the I-70 viaduct between Brighton and Colorado (see Section 5.3)
(3) Includes costs in footnote (1), and mobilization, contingencies, and other costs.

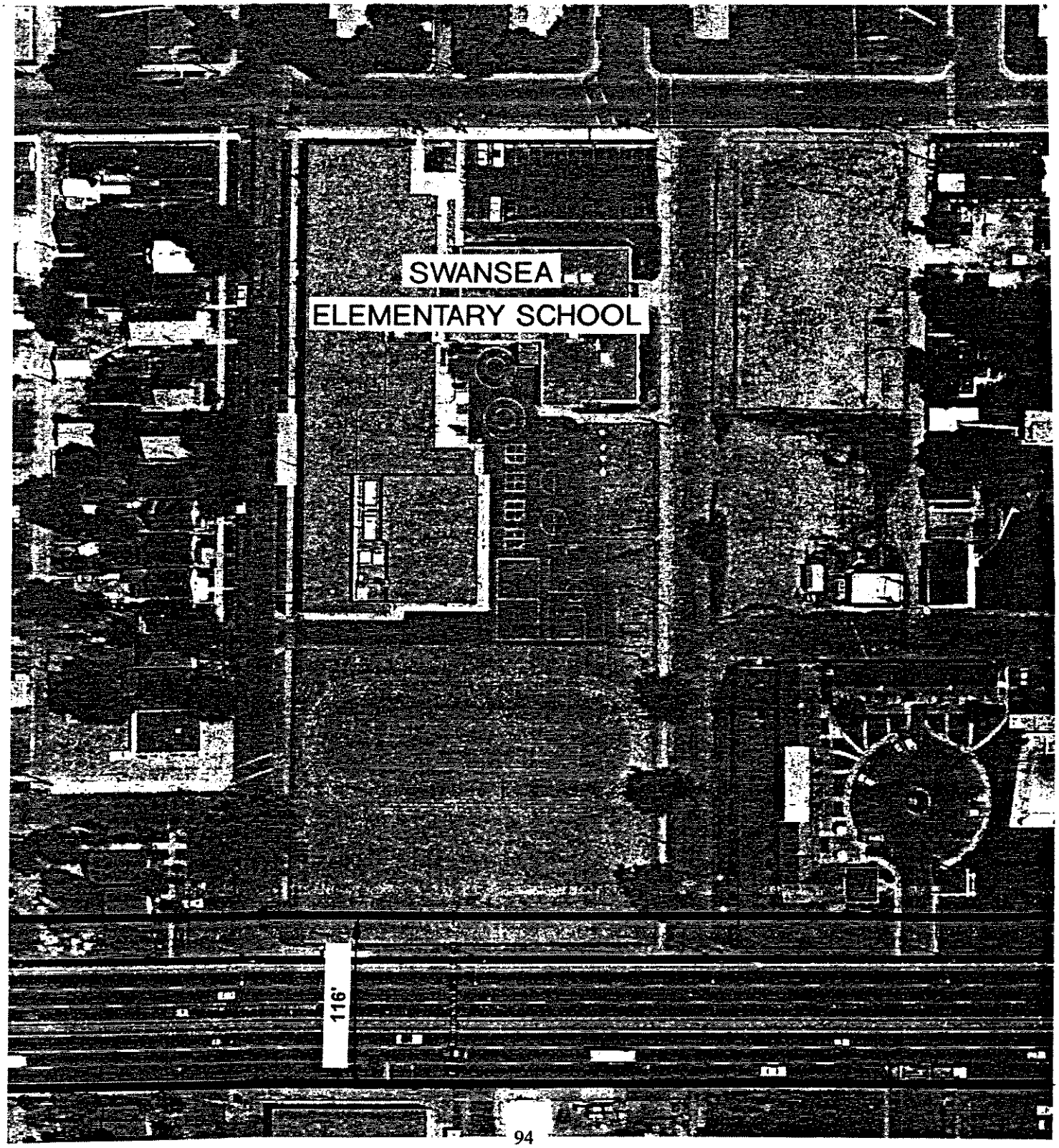
Table 5-6
Cost-Effectiveness of Recommended Corridor Investment

Criteria	Cost
Total Annualized Cost Per Annual User	$1.82
Annualized Cost Per Vehicle Mile of Travel Reduced	$4.80
Annualized Cost Per Person Hour of Delay Reduced	$4.68

Table 5-7
Community and Natural Resource Impacts

Criteria	Estimated Impacts
Community Impacts	
Displacements	
- Residences	2
- Businesses *(employees)*	2 *(75)*
Disruption--Remaining Homes within 300'	327
Streets Closed	5 +/-
Hazardous Materials: Number of sites *(anticipated impacts)*	56 sites (*no impacts)*
Environmental Justice	
Adverse:	
- miles bisecting minority or low-income areas//total miles	14.5/39
- residences acquired in minority or low-income areas/total residences acquired	2/2
- residences remaining within 300' in minority or low-income areas/total residences remaining within 300'	327/327
Benefits Denied to minority or low income areas:	None
Natural Resource Impacts	
Wetlands Disturbed (acres)	1-2 acres
Parklands and Wildlife Refuge Taken (acres)	none
Historic Properties Taken	none (7 properties within 400', no significant negative impacts)
Endangered Species: number (*anticipated impact*)	10 (*no impact*)

Figure 5-17
Impact of Widening I-70 Viaduct on Swansea Elementary School



Nearly all of the 327 homes remaining within 300 feet of an improved transportation facility are already within 300 feet of an *existing* transportation facility that already generates noise and vibrations, obstructs views, and has other proximity-related impacts. The provisions for noise abatement and landscaping included in the recommended corridor investment costs could actually *improve* conditions for some of the homes within the 300-foot distance.

The neighborhoods in the Corridor immediately east and northeast of downtown Denver are predominantly low-income and/or minority. The location of these neighborhoods makes it impossible to avoid impacting them, even if I-70 were simply reconstructed at its existing capacity. Accordingly, all of the residences acquired or remaining within 300 feet of an improved facility are in low-income or minority neighborhoods. As noted above, displacements would be minimal, and nearly all homes remaining within 300 feet of an improved facility are already within 300 feet of an existing transportation facility. Benefits from the recommended corridor investment would not be denied to residents in low-income and minority neighborhoods. Commuter rail stations at 40th St./40th Ave. and Stapleton are within easy access of minority neighborhoods and provide access to employment at DIA and in downtown Denver. The light rail extension is within a low-income minority neighborhood. It will provide residents with a direct transit connection to the commuter rail line, and offers greater accessibility to the existing Central Corridor light rail line.

There are no anticipated major impacts to any natural resources in the East Corridor. Only a minimum amount of wetlands would be affected. No significant air quality impacts are expected, based on emissions modeling conducted for previous alternatives upon which the recommended corridor investment is based (see **Table 4-9** in Chapter 4 for details).

6 IMPLEMENTATION

6.1 Phasing and Sequencing

Full implementation of the recommended corridor investment would occur over several years. This section briefly outlines a suggested phasing and sequencing strategy for the various components of the investment. The intent reflected is to stage the various improvements to address the most pressing mobility needs first while minimizing traffic impacts and stretching the funds needed over a 20-year or longer funding cycle. The suggested phasing and sequencing strategy is presented for discussion purposes only, and is not intended to define a set program or schedule for East Corridor improvements. These details would be determined by the relevant transportation plans and programs that incorporate components of the recommended corridor investment. Each major component of the recommended corridor investment would be subjected to the NEPA process, with its required public involvement procedures, to determine specific environmental impacts and appropriate mitigations.

In general terms, the recommended phasing and sequencing of the investment would occur as follows, with additional discussion of each in sections 6.1.1 through 6.1.3:

- *1998 - 2000:* Begin construction of commuter rail and light rail extension.
- *2001 - 2005:* Phase 1 of I-70 widening between I-270 and I-225 (four lanes each direction)
- *2006 - 2010:* Widen I-270 to three lanes in each direction *(While not a part of the recommended corridor strategy, this project is integrated with other projects in the corridor. See section 6.1.3 below)*
- *2011 - 2015:* Reconstruct I-70 viaduct between Brighton and Colorado
- *2016 - 2020:* Phase 2 of I-70 widening between I-270 and I-225 (five lanes in each direction)

6.1.1 Rail Improvements

The commuter rail line should be built in its entirety, as opposed to a series of incremental extensions. The primary reason for this is that the strongest travel market for commuter rail is between downtown and DIA. The commuter rail line also should be built before major reconstruction of I-70 takes place so the commuter rail line could mitigate some traffic congestion associated with highway construction. Pending the availability of funding, commuter rail should be pursued as the first major improvement to be implemented in the corridor.

Ideally, the light rail extension would be constructed simultaneously with the commuter rail line to provide system connectivity for transit riders.

6.1.2 Denver Proposal

The City and County of Denver has been pursuing commuter rail as a public-private partnership for several years. That effort

and the commuter rail element of the recommended corridor investment are quite similar. Denver staff members have indicated that commuter rail can be delivered at an "on-budget" capital cost not to exceed $220 million, as opposed to the approximately $316 million cost presented in this MIS analysis. Denver suggests that the lower cost can come about from construction cost savings due to private-sector design-build efforts. If not, the budget of "traditional" transportation resources could be supplemented by other revenue sources controlled by Denver. It is recommended that the implementing agency work with Denver to realize this proposal.

6.1.3 I-70 Improvements

The widening of I-70 between I-270 and I-225 could be implemented in two phases:

- Phase 1 would add only one additional lane in each direction, rebuilding inside shoulders for use as through lanes so structural widenings could be minimized. It would also not be necessary to rebuild the existing portion of I-70 in this first phase. Phase 1 would provide much-needed congestion relief in this segment within a shorter time frame and smaller budget than the full widening.

- Phase 2 of the I-70 widening in this segment would add another lane in each direction, making a total of five lanes in each direction between I-270 and I-225. The additional widening would not need to be done until I-270 is widened to three lanes in each direction, although structural work to support the widening could proceed in the interim. A railroad spur track near Havana would need to be relocated before Phase 2 construction could occur. This phase would completely reconstruct I-70.

Improvements to I-70 between I-225 and Peña Blvd. should be provided concurrently with Phase 2 of the larger widening, or sooner if demand dictates.

The viaduct between Brighton and Colorado does not necessarily need to be reconstructed in advance of other work on I-70, since this would not be a capacity-increasing improvement. For the most part, this reconstruction will be driven by the condition of the structure. Unless significant safety concerns emerge, there is no overriding benefit to reconstructing the viaduct until it has reached its useful life. Maintenance efforts should be directed toward maximizing its useful life so that earlier reconstruction would not be necessary. While the East Corridor MIS Policy Level Advisory Committee recommended that the viaduct reconstruction only include widening to bring the inside and outside shoulders to standard, it was noted that, during the EIS process, widening to accommodate additional lanes may be considered.

The widening of I-270 is an assumed improvement from the 2015 RTP. This improvement ideally should precede reconstruction of the viaduct so that it could serve as an alternate route (along with I-76) for through trips seeking to avoid the construction area.

6.1.4 Other Improvements

Widening of East 56th Ave. could occur whenever funding is available from local, regional, and private sources to do so. Widening could be implemented incrementally, focusing on the most-utilized segments first. The widening of the East 56th Ave./I-270 overpass could be incorporated into the I-270 widening project noted above.

Modification of existing bus routes to feed the commuter rail stations should occur in conjunction with the opening of the commuter rail line. New routes should be considered as sufficient development occurs in the areas they will serve.

Installation of hardware to support Intelligent Transportation Systems (ITS) in the Corridor should occur prior to major highway construction to optimize the rest of the transportation system and support construction mitigation strategies for traffic. Improvements to link the commuter rail stations to existing regional bicycle and pedestrian paths in the Corridor should be made in conjunction with the construction of commuter rail stations. New regional paths constructed after commuter rail has opened should concurrently provide the station linkages. Implementation of Transportation Demand Management (TDM) strategies should be pursued incrementally as development occurs in the Stapleton and Gateway areas.

6.2 Next Steps

Once approved and incorporated into the Regional Transportation Plan by the Denver Regional Council of Governments Board of Directors, the recommended corridor investment would be eligible for federal funding to accomplish federally required environmental review, preliminary engineering, design, and construction. Implementing agencies must secure approval to undertake the recommendations by their policy bodies. Federal funding sought by the implementing agencies must be programmed in the Transportation Improvement Program (TIP).

The East Corridor MIS was conducted as a precursor to the NEPA process, as allowed for under federal guidance. Accordingly, all components in the recommended corridor investment will be subject to the NEPA process, which will address how any adverse environmental impacts will be mitigated. The NEPA process for I-70 in the viaduct area may consider alternative cross-sections including additional widening. Fundamental to the NEPA process are proactive public involvement activities. Mitigation measures will be reflected in the project's design and, ultimately, the construction of the major investment.

Final design and right-of-way acquisition for elements of the recommended corridor investment will occur as the environmental process and project funding allow.

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