Transit Element of the 2030 Regional Transportation Plan

Technical Memorandum No. 3

PHASE 3: RECOMMENDED TRANSIT SERVICE AND FACILITY IMPROVEMENTS

Prepared for:

Pima Association of Governments

October 2003
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Pima Association of Governments

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October 2003

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1. Introduction

This Technical Memorandum documents results of Phase 3 for the Transit Element of the Pima Association of Governments Regional Transportation Plan (RTP) update for 2030. Phase 3 focuses on identifying recommended transit service and facility improvements for the Tucson region through 2030.

Transit Element Components

The Transit Element of the 2030 RTP encompasses three major phases. Phase 1, documented in Technical Memorandum 1 (March 2003), provides an inventory of existing transit services and facilities in the Tucson region. Phase 2, documented in Technical Memorandum 2 (June 2003), assessed potential transit markets and identified areas in the region that exhibit potential for transit growth. These areas will include major corridors that are expected to experience significant growth during the 25-year horizon of the RTP. Phase 3 of the Transit Element, which is the subject of this Technical Memorandum, identifies major transit improvements—service, facilities, and supporting actions—that will meet mobility needs of the region.

Overview of Technical Memorandum

Following this Introduction, Section 2 identifies key direction for transit improvements based on findings from previous phases of the Transit Element. This section also documents major goals that the transit recommendations should meet based on results from Phases 1 and 2 of the Transit Element. Section 3 describes three potential alternatives that can be considered for transit service and facility improvements. The alternatives are presented in sufficient detail to allow cost estimating. While each alternative provides direction for the region with regard to transit development, final decisions on a recommended program of improvements will be identified later in the 2030 RTP process. Section 4 concludes the memo with a presentation of supporting strategies for the Transit Element recommendations.
2. Direction for Transit Improvements

This section summarizes major direction for future transit service and facility improvements. Transit service and facility improvements recommended in this Technical Memorandum are based on a variety of factors and needs. A major overriding factor is the growth in both population and employment within the Tucson region and the resulting increases in demands on the transportation system. This system includes various public transportation modes such as fixed routes and paratransit.

In order for public transportation to maintain or increase its share of total travel, major increases in service hours will have to be provided. Increased service and resulting ridership are important for major travel corridors in the Tucson region, particularly the nine high-capacity transit (HCT) corridors identified in Phase 2 of the Transit Element.

Direction for transit recommendations was provided by the two previous phases of the Transit Element for the 2030 RTP. This direction was based on a review of existing transit services and facilities. It also included transit planning efforts carried out by local jurisdictions in the Tucson region. Under Phase 2, various markets for transit services were identified based on demographic characteristics, future land use densities, and travel patterns. These markets, which included major travel corridors, provide direction for future transit service and facilities.

Inventory and Assessment of Existing Transit Services/Facilities

Under Phase I of the Transit Element for the 2030 RTP (Technical Memorandum 1), several key findings provided direction for potential transit service. These findings include the following:

- While the large majority of transit services are located in the urban area of the Tucson region, major population and employment growth will be taking place in outlying areas.
- Until FY 2002–2003, there had been a general decline in Sun Tran ridership during the past five years; but growth has occurred for smaller systems like Oro Valley’s Coyote Run and the University of Arizona’s CatTran service.
- Major transit demand occurs on a few major corridors; this provides a basis for future transit development.
- Transit studies conducted by local jurisdictions indicate several needs such as expanded service availability to include later evening service.
- There is lack of a major system of express bus service and major (greater than 200 spaces) park-and-ride capacity for emerging travel needs, particularly in low-density areas.
- Under paratransit services for persons with disabilities, there are some unmet needs that are now being addressed by expanded service supply; however, future paratransit demand will be significant during the 25-year RTP period.
- There is lack of major planned improvements, partly due to lack of dedicated funding for public transportation. For example, other than a planned transit center at Udall Park, there are no plans for major new transfer facilities in the region even though the three existing centers play a key role in Sun Tran’s route structure.
Future Transit Growth Markets

Phase 2 of the Transit Element (Technical Memorandum 2) identified several areas dealing with current and future travel markets affecting public transportation. These markets include emerging major travel corridors, sub-area population and employment growth, and key mobility issues facing groups such as seniors and persons with disabilities. Major findings from the market assessment include the following:

Major Corridors

- Emerging major travel corridors for work-related and total trips affect areas throughout the region. Connections involving southeast Tucson, Marana, Oro Valley, Sahuarita, and Green Valley will be particularly significant.

- Significant infill will take place along eight identified major transit corridors: Speedway, Oracle Road, 6th Avenue, Broadway, Alvernon, 1st Avenue, Campbell, and Wilmot.

- Nine potential HCT corridors connect several communities within the Tucson region. Key factors used to identify potential HCT corridors include:
  - Current ridership levels;
  - Regional travel affecting the corridor;
  - Land use densities;
  - Demographic characteristics;
  - Transit-supportive measures, policies, and actions; and
  - Other considerations such as the University of Arizona’s Comprehensive Campus Plan adopted in 2003.

Demographic Characteristics and Density Patterns

- Areas with land use densities supporting regular public transit services will grow. Due to their relatively low densities, large parts of the region’s future growth areas will not lend themselves to regular fixed route transit solutions. However, these areas still can be served by other transit and mobility options such as demand response service, express bus access provided park-and-ride lot capacity is available, and vanpool programs.

- Using the street system, much of the region’s high-density development will follow a north-south or east-west orientation. Affected corridors include but are not limited to:
  - Oracle/Stone between River Road and Downtown Tucson;
  - 6th/12th Avenue between Laos transit center and Downtown Tucson; and
  - Broadway/Speedway between Houghton and University of Arizona/ Downtown Tucson.

- Several key demographic patterns that indicate potential transit markets are also located along these major north-south and east-west corridors.

- While significant suburban development is planned, the area bounded by Downtown Tucson, Tucson Mall, Laos transit center, and Park Place will remain the region’s urbanized core area.
Local Development Plans and Policies

- Jurisdictions in the Tucson region have recommended policies and action plans that are supportive of transit.
- Planned revitalization efforts, such as the Rio Nuevo project, will strengthen the Downtown Tucson-based market. Parking management strategies will also improve transit’s competitiveness within the downtown market.
- With its planned expansion and potential limitations on campus parking, the University of Arizona may take on a greater role as a focus for potential high-capacity transit services in the central Tucson area.

Issues Relating to the Elderly and Persons with Disabilities

- Some areas of Tucson where persons with disabilities reside are not currently served by transit.
- Access to transit is a key factor in the selection of housing locations by persons with disabilities.
- Several bus routes have particularly high use by persons with disabilities.
- Several barriers currently exist regarding the disabled markets:
  - For fixed route service, barriers involve sidewalk access to bus stops, lack of amenities at bus stops (e.g., shade), and difficulty accessing buses
  - For paratransit service, key barriers include the reservations system and determinations of boundaries for services relating to the Americans with Disabilities Act (ADA)
- In considering potential improvements relating to service for persons with disabilities, one strategy could entail identifying accessible transit corridors that have good transit service and amenities such as passenger shelters.
- For the elderly, some barriers to public transit involved lack of familiarity with the system as well as concerns about comfort, safety, and security.

Key Goals for Transit Improvements

The major findings from Phases 1 and 2 of the Transit Element provide important direction for goals that can be used in developing recommended transit improvements. Key goals are:

1. Provide more convenient transit service that meet needs of those who are dependent on public transportation for their mobility needs and those who can choose between driving and taking public transit.
2. Enhance transit services and facilities to meet needs of seniors and the disabled, in compliance with the Americans with Disabilities Act.
3. Improve inter-modal connections and access to transit service for a variety of users, including pedestrians as well as those who rely on park-and-ride services.
4. Reduce transit travel times so that they are more competitive with auto travel times.
5. Develop strategies that meet travel demand along identified high-capacity transit corridors.
6. To help mitigate future traffic congestion and reduce necessary additional street/highway capacity, increase transit ridership by those who can choose between driving and taking public transportation.

7. Pursue necessary local, state, and federal funding to support transit improvements.

8. Provide a planning and administrative framework that allows a regional, multi-agency approach to implementing transit improvements.

9. Improve the overall image of public transit through improved maintenance, innovative marketing strategies, and the use of modern equipment and facilities.

10. Improve transit services to major employment centers in order to support efforts to reduce vehicle miles traveled.

11. Reduce vehicle miles traveled in order to aid the region in remaining in attainment with the National Ambient Air Quality Standards.
3. Recommended Public Transit Improvements

In this section, three recommended public transit alternatives are identified. Each successive alternative builds on the previous one to offer a menu of transit service and facility improvements that are in addition to what is available today. Alternative 1 includes a variety of relatively inexpensive yet important transit improvements to primarily meet the basic needs of the transit dependent. This alternative is basically an improvement of existing services. Alternative 2 includes those recommendations identified in Alternative 1 plus improvements that are aimed at attracting more choice riders through expanded services and facilities. Alternative 3 includes recommendations from Alternatives 1 and 2 plus major infrastructure improvements along key high-capacity transit corridors, as well as strong integration with land use development. Some minor bus changes are also included in Alternative 3 as a result of major HCT developments.

Alternative 1—Focus on Improvements for Transit Dependents in Existing Service Areas

Alternative 1 is mainly focused on meeting the basic needs of the transit dependent by strengthening the existing core transit network. It does not try to address in a major way issues relating to congestion or environmental degradation. To reinforce this focus on the transit dependent, improvements include expansion of fixed route service span to allow later evening service, higher levels of frequencies along corridors with existing major transit demand, new neighborhood oriented services, expanded paratransit for persons with disabilities, improved access and amenities at bus stops, and use of modern low-floor buses. Vanpool and rideshare programs will be expanded to address service in low-density areas along regional corridors.

The following further describes service elements included in Alternative 1. This is followed by descriptions of capital items for the alternative.

Service Recommendations under Alternative 1

Table 1 provides an overview of various service improvements that have been identified for Alternative 1 while Figure 1 identifies key components of the alternative. It should be emphasized that these recommendations indicate a potential direction for service development in the Tucson region over a 25-year time span. A level of detail has been provided to allow an initial estimate of potential costs. However, before any implementation of service, more detailed service and related capital planning will need to take place.

**Fixed Route Service—Frequency Improvements**

Frequency improvements are intended to meet expected growth in demand along major travel corridors, particularly the nine HCT corridors identified in Phase 2 of the Transit Element. Routes that could be affected are: #3–Sixth Street/Wilmot, #4–Speedway, #6–1st Avenue, #7–22nd Street, #9–Grant, #10–Flowing Wells, #11–Alvernon, #15–Campbell, #16–Oracle, and #19–Stone.
Table 1
Summary of Recommended Service Improvements under Alternative 1

<table>
<thead>
<tr>
<th>Recommended Improvements</th>
<th>Major Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Frequency Improvements</td>
<td>Peak and midday service improvements are recommended for the following major corridors:</td>
</tr>
<tr>
<td></td>
<td>• Sixth Street/Wilmot</td>
</tr>
<tr>
<td></td>
<td>• Speedway</td>
</tr>
<tr>
<td></td>
<td>• 1st Avenue</td>
</tr>
<tr>
<td></td>
<td>• 22nd Street</td>
</tr>
<tr>
<td></td>
<td>• Grant</td>
</tr>
<tr>
<td></td>
<td>• Flowing Wells</td>
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<td></td>
<td>• Alvernon</td>
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<tr>
<td></td>
<td>• Campbell</td>
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<tr>
<td></td>
<td>• Oracle</td>
</tr>
<tr>
<td></td>
<td>• Stone</td>
</tr>
<tr>
<td>Service Period Extensions</td>
<td>• Focus is on expanded service hours to 11 p.m. or later on 26 existing bus routes.</td>
</tr>
<tr>
<td></td>
<td>• Service extension affect routes operating in areas with major employment/activity areas.</td>
</tr>
<tr>
<td>Weekend Services</td>
<td>• Expansion of service by 3 hours (both earlier and later service) on Saturdays and by 2 hours on Sundays. Affects all routes in urban area.</td>
</tr>
<tr>
<td>Service Area Extensions</td>
<td>• Rt. 16: Extend alternate trips to Oro Valley and Cortaro Farms Road.</td>
</tr>
<tr>
<td></td>
<td>• Rt. 9: Extend Service to Bear Canyon Plaza.</td>
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<td></td>
<td>• Rt. 3: Extend service to Houghton Road at I-10.</td>
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<tr>
<td></td>
<td>• Rt. 10: During weekdays, extend alternate trips to Foothills Mall.</td>
</tr>
<tr>
<td>New Local Routes</td>
<td>• River Road–Udall TC to Cortaro Road via Tohona Tadai TC.</td>
</tr>
<tr>
<td></td>
<td>• Midvale Park and Valencia to Udall Park via Los Reales (Aero Park during commute), Valencia and Kolb.</td>
</tr>
<tr>
<td></td>
<td>• Camino Seco between Udall Transit Center and PCC East</td>
</tr>
<tr>
<td></td>
<td>• Harrison between Udall Transit Center and PCC East.</td>
</tr>
<tr>
<td></td>
<td>• Green Valley–Laos Transit Center-Downtown Tucson</td>
</tr>
<tr>
<td>Neighborhood Routes for General Public</td>
<td>New services will be supported by new transit centers to allow convenient connections with other services. Potential locations for the services are:</td>
</tr>
<tr>
<td></td>
<td>• Oro Valley.</td>
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<tr>
<td></td>
<td>• Marana – expansion of existing Pima County Service.</td>
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<tr>
<td></td>
<td>• Foothills area between Sabino Canyon and Oracle Road</td>
</tr>
<tr>
<td></td>
<td>• Foothills area/Bear Canyon</td>
</tr>
<tr>
<td></td>
<td>• Network of shuttle routes in SE/Houghton Road/Rita Ranch area.</td>
</tr>
<tr>
<td></td>
<td>• Green Valley/Sahuarita.</td>
</tr>
<tr>
<td></td>
<td>• Southwest area; expand existing San Xavier and Tucson Estates routes.</td>
</tr>
<tr>
<td>Paratransit</td>
<td>• Support for community-based volunteer program—including funding for the programs and contributions of surplus vehicles from paratransit fleets.</td>
</tr>
<tr>
<td></td>
<td>• Double total fleet size and service hours for regional paratransit services.</td>
</tr>
<tr>
<td>Vanpool/Regional Ridesharing</td>
<td>• Subsidized vanpool program in targeted areas of the region.</td>
</tr>
</tbody>
</table>

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Figure 1

Alternative 1 - Recommended Major Improvements

Transit Element / 2030 RTP

 Neighborhood Circulator Service
 Neighborhood Circulator Service
 Neighborhood Circulator Service

= NEW MAINTENANCE FACILITY
= NEW TRANSIT CENTERS
= NEW ROUTE
= ROUTE EXTENSIONS

Frequency Improvements and Service Period Extensions on Several Existing Routes

RTE. 16 EXTENSION
RTE. 10 EXTENSION
RTE. 9 EXTENSION
NEW HARRISON RTE
NEW CAMINO SECO RTE
NEW ROUTE ON I-19
NEW VALENCIA/KOLB RTE

Neighborhood Circulator Service
Neighborhood Circulator Service
Neighborhood Circulator Service
Neighborhood Circulator Service
Neighborhood Circulator Service
Neighborhood Circulator Service
Frequency improvements will result in the following service levels along the following corridors:

- Sixth Street/Wilmot—15 minutes all day
- Speedway—10 minutes in peaks
- 1st Avenue—10 minutes in peaks north of Laos transit center; 15 minute in peaks south Laos Transit Center
- Flowing Wells—15 minutes in peaks
- Alvernon—10 minutes in peaks
- Campbell—10 minutes in peaks
- Ten-minute service in peaks south of Tucson Mall; Oracle; 15 minutes in peaks north of Tucson Mall

**Fixed Route Service—Service Period Extensions**

Currently, several existing routes in the urban area of Tucson stop operating in the early evening. Service extensions to 11 p.m. are recommended for 28 Sun Tran routes. Service period extensions are intended to meet mobility needs for a variety of users, particularly those employed in service jobs with late evening quitting times.

For three routes (#4—Speedway, #8—Broadway/S Sixth Street, and #16—12th Avenue/Oracle), service is extended to 12 a.m. These are heavily traveled routes serving corridors that are expected to grow significantly in population and employment. For Route 16, the recommended service period extensions will affect Oro Valley and Marana (see service coverage extensions below).

**Fixed Route Service—Service Coverage Extensions**

Four route extensions are recommended to address growth in suburban areas of the region as well as the lack of transit coverage in existing and projected future urbanized areas. The following identify the routes and the proposed extensions.

- **Route 3—5th/Sixth Street:** Service currently ends at Pima College East
  - Extend service to Rita Ranch/Houghton Road area
- **Route 9—Grant:** Service currently ends at Tanque Verde and Pantano
  - Extend Service to Bear Canyon Plaza
- **Route 10—Flowing Wells:** Service currently ends at Tucson Mall
  - Extend alternate trips during weekdays to recommended new transit center at I-10/Cortaro Road.
- **Route 16—12th Avenue/Oracle:** Service currently ends at Ina and Thornydale
  - Extend alternate trips to Rancho Vistoso Boulevard in Oro Valley and Cortaro Farms Road in Marana

**New Local Routes**

Several potential new fixed routes are recommended under Alternative 1. These new routes will operate in areas not currently served by transit, including urbanized areas of unincorporated Pima County.
• River Road from a new Udall transit center to Cortaro Road via Tohona Tadai transit center
• Midvale Park/Valencia to Udall transit center via Los Reales (Aero Park during commute), Valencia and Kolb
• Udall Center to PCC East via Camino Seco;
• Udall Center to PCC East via Harrison
• Green Valley (I-19/Esparanza) to Downtown Tucson via Laos transit center

Cost of Congestion Factor

In addition to potential service improvements to address emerging market needs, future transit development will need to address expected congestion on major streets. This congestion will result in longer operating periods for buses. To account for this, a cost of congestion factor will need to be recognized. For planning purposes, total annual service costs are increased by 20 percent to account for costs of congestion. This results in less than a 1.0-percent average growth per year for the 25-year plan period.

Neighborhood Services

The above recommendations address changes to existing transit routes operating in the region. Recommendations under Alternative 1 also include a type of service that will be new to the region. These are neighborhood services that provide access to low-density areas. The ALEX (Ahwatukee Local Explorer) route in Phoenix is one example of this type of transit service. This service is operated by a private contractor through Valley Metro.

There are several methods to provide this type of service, including route deviations which have fixed schedules at key locations such as a senior center but also provide access off-route to meet demand. Passengers waiting at the fixed schedule locations (or checkpoints) do not have to call in for service. For service outside these locations, customers request the service.

The following are recommended locations for neighborhood-oriented local service. For the costing assessment, it was assumed that each neighborhood-oriented service will provide 30-minute frequency during peak and midday periods. The services are in addition to existing paratransit operations such as Oro Valley’s Coyote Run.

• Oro Valley Area Circulator: Coyote Run provides paratransit service to elderly and persons with disabilities. Currently, there is no circulator service available to the general public.
  o Recommended improvement: Implement neighborhood circulator for the general public (per the adopted Transit Development Plan for Oro Valley).
• Marana Area Circulator: Contracted service with Pima County (elderly and disabled).
  o Recommended improvement: Implement neighborhood circulator for general public. Expand existing Pima County Rural Transit Service.
• **Northeast Area**: Limited service in area north of Rillito River/Tanque Verde Creek.
  - Recommended improvement: Implement neighborhood route in Foothills area between Sabino Canyon and Oracle Road, and a neighborhood route in the Bear Canyon area. Consideration should be given to the neighborhood shuttle serving the Sabino Canyon Recreation Area during peak demand periods. This will help reduce parking congestion near the main entrance.

• **Southeast Area/Rita Ranch**: No service is currently operating.
  - Recommended improvement: Implement network of shuttle routes in Southeast/Houghton Road area.

• **Green Valley/Sahuarita Area**: No service is currently operating.
  - Recommended improvement: Neighborhood circulator for the general public.

• **Southwest Area**: Fixed routes operated by Pima County but limited service in area, particularly in the midday periods.
  - Recommended improvement: Upgrade service levels in peak and midday periods; extend service hours. Expand existing San Xavier and Tucson Estates services into regular routes operating every 30 minutes.

To ensure the effectiveness of these neighborhood services, it will be important to have convenient connections with traditional fixed route services. Transfer facilities are addressed in the capital component of the Alternative 1 recommendations.

**TICET and CatTran Services**

No specific services changes are called out for the TICET service operated by the City of Tucson or for the University of Arizona’s CatTran service. However, it is expected that each of these services will expand as demand warrants. Additional possible improvements include new CatTran routes that extend further into the U of A campus area.

**Paratransit Services**

Recommendations for paratransit service fall under two categories: support for volunteer-based services and ongoing expansion of public services for persons with disabilities.

**Volunteer Programs**

The volunteer program would provide relatively low-cost support for community-based volunteer programs. These programs can be aimed at seniors as well as persons with disabilities who may not have their needs met by more traditional paratransit services. Two successful programs in the Tucson region are the *Old Fort Lowell Live-at-Home Program, Inc.* and *Catalina Community Services* (formerly known as *Catalina Helping Hands*).

The level of support can involve reimbursement for mileage and assistance with liability insurance. To serve neighborhoods in need, recommendations call for ten programs per year at a cost of $15,000 per program. Additional and relatively minor costs can come from donations of surplus vehicles when paratransit providers purchase new vehicles.
Paratransit Services for Persons with Disabilities

Under each alternative, more traditional paratransit services will need to expand in order to meet expected growth in the paratransit market. One approach to determine required service growth is to have it follow the estimated rate of growth for total population in the region. By 2030, the region’s total population will grow by almost 70 percent. However, the fixed route expansion previously called out in this alternative will necessitate expansion of paratransit service consistent with the Americans with Disabilities Act. For long-range planning purposes, the growth rate of paratransit services should be 100 percent higher than current levels. This higher rate, versus population growth, recognizes the expected growth in senior population in the Tucson region due in large part to the aging of the baby boom generation. Many of these seniors will gradually develop mobility problems to the point that will require paratransit services.

In addition to service-related improvements, paratransit recommendations also include improved access at bus stops. These improvements are further described in the capital-related recommendations for Alternative 1.

Vanpool Program

While Alternative 1 emphasizes service improvements for the transit dependent, vanpool options also are recommended for transit choice riders who currently live outside existing service areas. These vanpool efforts should involve some level of subsidy to potential users. The Pima Association of Governments currently provides a subsidy of up to $400 per qualified van for up to one year, and thereafter as funding remains available.

The following describes potential improvements:

- **Sahuarita/Green Valley/Southeast Industrial Area**: Subsidized program of vanpool services to Southeast Tucson industrial area.

- **Southeast Area/Rita Ranch to Southeast Industrial Area**: Subsidized program of vanpool services to Southeast Tucson industrial area.

- **Marana/Northwest Area**: Subsidized program of vanpool services to Southeast Tucson industrial area.

- **Ajo Highway Corridor/Pasqua Yaqui Pueblo**: Subsidized program of vanpool services from Sells to Laos Transit Center and Downtown Tucson.

As part of any regional vanpool program, a Guaranteed Ride Home element should be provided. Most employers participating in the region’s Travel Reduction Program currently provide a guaranteed ride home to employees who have a family or medical emergency. PAG’s Rideshare Program provides a Regional Guaranteed Ride Home Program.

The region’s vanpool program should also consider use of vehicles for two-way trips. Traditionally, AM peak vanpools operate in one direction, usually to a major employment site. There recently have been more examples of agencies organizing *van sharing*. In many cases, this sharing includes commuters taking a vanpool in the AM period to a major transit...
hub such as a commuter rail station. At the hub, another set of vanpool riders (coming off the train) take the van to an employment area. The reverse process occurs in the PM peak. At some future point in the Tucson region, this process can occur at the new park-and-ride lots called out under Alternative 2. Combined with reverse commute bus service, it can provide transit access to suburban employment areas.

**Capital–Related Recommendations under Alternative 1**

Several capital-related items will be necessary to support various service improvements under Alternative 1. These capital items are summarized in the following sections. It should be noted that cost estimates for any of the items are preliminary only. More detailed costing will be necessary as each project proceeds in terms of design as well as, for federally funded projects, environmental assessment.

**New Bus Acquisitions for Service Expansion**

Bus acquisitions directly relate to service improvements involving expansion occurring during peak periods. Recommendations call for 58 additional 40-foot buses for existing and new line-haul routes and 15 additional 30-foot minibuses (or 32-foot buses provided by some vendors) for new neighborhood oriented service routes. Shorter buses can better serve residential streets and are perceived to be more neighborhood-friendly. It will be important for all new buses (for both expansion and replacement) to have low floors. This feature will allow convenient and quick boardings, particularly for those with mobility problems. New buses also should incorporate alternative fuels such as compressed natural gas (CNG). This will allow the Tucson region to remain in compliance with State Rule 49-571 and reduce air pollutant emissions.

For neighborhood-oriented services using small buses, vehicles should have a distinct look that will help attract ridership. The photo below is of a small vehicle used in the *Hop* service operating in downtown Boulder, Colorado. The vehicle has features such as large windows, low floors, and double doors for easy access.

The design selection process for the small buses can incorporate an identity associated with the individual communities being served. This process provides an opportunity for members of the community to become involved in the vehicle design process thereby taking on a sense of ownership of the service.

**Additional Paratransit Vehicles/Maintenance–Operating Expansion**

Expansion of paratransit service under Alternative 1 will require significant growth of the region’s fleet of paratransit vehicles. To support the service expansion, approximately 90 additional vehicles will be required.
**Added Capacity for Paratransit Maintenance and Operations Center**

Due to the above-noted significant expansion of paratransit service called for in this alternative, additional capacity will be required for maintenance and operations of the fleet. The expansion by approximately 90 vehicles will not likely be met by existing facilities. It is possible that a regional approach to providing this additional capacity be considered. This can be done through single or multiple new facilities or expansion of existing facilities but all shared by several paratransit operators.

**Transit Centers**

Development of several neighborhood circulators is a key component of Alternative 1. In order to provide effective service coverage, these neighborhood services should have convenient and safe locations for connecting with the regional fixed route network.

Transit center development is recommended at five locations:

1. Oro Valley in the Oracle Road and 1st Avenue vicinity
2. Marana in the Cortaro Road/I-10 area vicinity
3. Northeast/Foothills area in the Udall Park vicinity
4. Southeast area at PCC East and in the Rita Ranch/Houghton Road growth area vicinity
5. Green Valley in the I-19/Esparanza Boulevard vicinity

Transit center improvements are expected to be relatively small-scale, with an estimated cost of approximately $1.0 million each. Consideration can also be given to a new transit center in the vicinity of Park Place (Broadway/Wilmot). Service changes included in the Transit Element alternatives do not indicate an immediate need for this facility. However, as more detailed service plans are developed, a new transit center at this location could be justified to help bring about operating efficiencies.

At several locations in the region, transit centers can help address reverse commute travel patterns. These trips vary from the more traditional commute travel patterns in that during the AM period they start in the more central areas of a region and end in outlying employment centers. The growth in suburban employment has resulted in corresponding increases in reverse commute travel. In Tucson reverse commute includes travel originating from central areas and resorts located in the Foothills area. The combination of proposed new transit centers and recommended neighborhood oriented services will help address reverse commute travel demand.

In addition to providing a good interface between local and regional public transit services, new transit centers should accommodate services operated by private transit service operators. By having a staging area with space for ticketing, more convenient overall access to intercity service can be provided by a wider selection of transit operators. One potential example is use of the future Oro Valley transit center for accessing shuttle services to Tucson International Airport and Sky Harbor airport in Phoenix. Currently, residents in the
northwest area of the region have to access these services in Downtown Tucson or along Ina Road.

**Pedestrian Access and Bus Stop Improvements**

With new and expanded service that is called out in Alternative 1, it will very important to have convenient and safe access to bus stops and transit centers, particularly for persons with disabilities. Shelters are essential to provide shade, seating, and route information especially for those who may have discomfort with lack of familiarity at bus stops.

Recommendations call for continued expansion of bus shelter improvements, provided by private vendors, and construction of new sidewalks along all major transit corridors. The focus should be on improvements at major transfer points—not just transit centers. Improvements at transfer locations will be particularly important for persons with disabilities. Their housing decisions are in large part based on adjacency to those locations served by multiple routes.

Before any major program of access and stop improvements is underway, a comprehensive inventory should be undertaken of existing stops and access to these stops. This effort should be coordinated with PAG’s current sidewalk inventory effort and bus stop data provided by local jurisdictions and transit agencies. For the purpose of costing estimates, sidewalk enhancements/bus stop improvements are identified at 100 locations in the Tucson region.

**Real-Time Information Systems**

Real-time information uses state-of-the art technology to provide transit riders with exact times for bus arrivals at major stops and stations. Sun Tran is currently implementing a real-time information program to install more than 100 display monitors at key stops along major transit corridors. Once installed, these displays will make transit more user-friendly by providing passengers with actual bus arrival times, instead of depending on printed schedules.

Recommendations call for installation of real-time information displays at 100 additional locations in the Tucson region beyond the number of installations that have been identified by the City of Tucson. These locations should include selected new transit centers identified under Alternative 1. Priority should also be given to additional placements on high-ridership routes and stops, particularly at transfer locations.

**New Maintenance and Operations Center for Fixed Route Service**

The significant expansion of the regional bus fleet will require a new maintenance and operation facility. The City of Tucson and Sun Tran have already initiated efforts to develop a new facility in the northwest area of the city in the area of Prince and Romero Roads. This location appears appropriate given the recommended growth in transit service in the northwest area. Per the City of Tucson Five-Year Capital Improvement Program, the facility is estimated to cost $27.7 million, with $4.2 million un-funded. The new maintenance and

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1 Conversation with staff of DIRECT Center for Independence.
operations facility is expected to accommodate 250 additional vehicles for fixed route services.

**Downtown Intermodal Depot Completion**

The City of Tucson is currently in the process of renovating the historic Southern Pacific rail station, now known as the Downtown Intermodal Depot. When completed in 2005, the depot will house a variety of transit-related services: the Amtrak station, the Greyhound bus terminal, a taxi stand, and loading for private tour buses and airport shuttles. Per the City of Tucson’s Five-Year CIP, the Intermodal Depot project is funded at $15.2 million.

**Alternative 2—Greater Emphasis on Meeting Needs of the Transportation Transit Choice Market**

All service and capital improvements identified in Alternative 1 will be included in Alternative 2. Additionally, Alternative 2 will include service and facility enhancements that will attract more choice transit riders. To achieve this goal, greater focus is given to reduced transit travel times and more convenient access to transit in non-urbanized but growing areas of the region. Examples include upgraded/direct express bus service supported by development of major park-and-ride lots in outlying areas of the region. Improvements also include implementation of Intelligent Transportation Systems (ITS) signal preemption for buses operating along high-ridership transit corridors.

Future park-and-ride lot development can include shared parking at shopping centers, churches, etc. But the major emphasis under Alternative 2 will be on more extensive park-and-ride lot development along major highways and arterials. These park-and-ride lots can also provide opportunities for joint use development such as housing, restaurants, and small-scale retail. The transit center development identified in Alternative 1 will support connections between non-traditional/local services and the express/regular fixed route service. The park-and-ride lot program under Alternative 2 should be integrated as much as possible with the transit center development.

**Service Recommendations under Alternative 2**

Table 2 summarizes major items under Alternative 2 while Figure 2 illustrates various components of the alternative. Service recommendations include enhancements along existing transit corridors as well as new express connections to major employment concentrations. These enhancements can be considered initial steps to creating more extensive high-capacity transit service such as Bus Rapid Transit service on major corridors.

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*Communication with Sun Tran staff (August 2003)*
### Table 2

**Summary of Recommended Improvements under Alternative 2**

<table>
<thead>
<tr>
<th>Recommended Items</th>
<th>Major Characteristics</th>
</tr>
</thead>
</table>
| **New/Upgraded Express Bus Service operating from 6 major park-and-ride lots (average of 300 spaces/lot)** | The new express service will connect the following locations:  
  - Oro Valley/U of A/Downtown Tucson  
  - Marana/SE Ind. Area  
  - North-South Corridor between Oro Valley, Downtown Tucson, and TIA/Industrial Area  
  - Corridor between east and central Tucson and TIA/SE industrial area (via Kolb)  
  - Green Valley/Sahuarita to TIA/SE Industrial area and Downtown Tucson  
  - Houghton Road/SE Tucson to Downtown Tucson  
  - Shuttle service in SE Industrial Area to provide connections between the proposed transit center and major employment areas |
| **New Limited/Skip Stop Overlay Service along 7 major arterials**                   |  
  - Speedway in peak periods between Speedway/Harrison and Downtown Tucson  
  - Broadway Corridor–expanded limited stop service between Speedway/Harrison and Downtown Tucson  
  - 6th St./Wilmot/Stella between PCC East and Downtown Tucson  
  - In peak periods, skip stop service on extended Campbell/Kino Parkway coverage connecting Cortaro Farms Road, Tucson Mall, U of A, and TIA  
  - In peak periods on 6th Avenue between Laos transit center Downtown Tucson  
  - Houghton Road between Irvington and Speedway  
  - Between Pima College West and Downtown Tucson/U of A |
| **Trolley Extension to Rio Nuevo**                                                |  
  - Extension of existing rail service south from the University of Arizona area and west to the Rio Nuevo area. Rail service will be provided daily. Service characteristics will be similar to those identified in the *Draft Rio Nuevo Transit Analysis* (March 2001). |
Figure 2
Alternative 2 - Recommended Major Improvements (In Addition to Improvements Identified in Alternative 1)

Transit Element / 2030 RTP

Legend:
- **P** = NEW PARK-AND-RIDE LOTS
- **T** = NEW TRANSIT CENTERS
- **=** NEW SKIP STOP SERVICE
- **=** NEW EXPRESS ROUTE

Note: The map shows proposed improvements including new transit centers, park-and-ride lots, and service enhancements. The improvements are indicated with symbols at various locations across the region, highlighting key transit stops and service changes.
New Express Service

Several new express routes are recommended that will provide direct transit service between growing population areas and major concentrations of employment sites. The corridors affected by these new routes are included among the nine HCT corridors previously identified in Phase 2 of the Transit Element.

- **North-South Corridor between Oro Valley, U of A, and Downtown Tucson:**
  Existing service operates between Oro Valley and Tucson Mall (Route 16–Downtown Tucson Route 162–Oro Valley Express, and Route 103 Old Father Express).
  - **Recommended Improvements:** Direct peak-only express service between 1st Avenue/Oracle Road and University of Arizona/Downtown Tucson. This will be supported by a new park-and-ride lot in the 1st Avenue/Oracle Road vicinity.

- **Marana/Southeast Industrial Area:** No current service.
  - **Recommended Improvements:** Direct peak-only express service between I-10/Cortaro Road and Southeast Industrial. Area of Tucson; supported by new park-and-ride lot in the Cortaro/I-10 vicinity.

- **North-South Corridor between Oro Valley, Downtown Tucson, and Tucson International Airport (TIA)/SE Industrial Area:** Currently Route 6 serves a portion of the corridor
  - **Recommended Improvements:** Continuous peak period express service between Oro Valley (Oracle Road/1st Avenue vicinity) and TIA via Downtown Tucson and South Tucson area; shuttle service from TIA to industrial area. Supported by new park-and-ride lot in general vicinity of Oracle Road/1st Avenue.

- **Corridor between East and Central Tucson and TIA/Southeast Industrial Area:** Currently served by Route 180: AeroPark Express, which operates limited service in peak periods.
  - **Recommended Improvements:** Expanded express service from park-and-ride lot in Northeast Area (expanded existing lot at Speedway/Harrison or new lot in vicinity of Tanque Verde/Harrison); shuttle service from new TIA transit center to industrial area.

- **Green Valley/Sahuarita to TIA/SE Industrial area and Downtown Tucson:**
  No existing service.
  - **Recommended Improvements:** Direct peak-only express service between general area of I-19/Helmet Peak Road and Southeast Industrial area. Start service in Green Valley (commercial area near I-19); serve new park-and-ride lot in I-19/Helmet Peak Road-Sahuarita Road vicinity. The link to Tucson can be via I-19 or the Old Tucson-Nogales Highway.

- **Houghton Road/Southeast Tucson to Downtown Tucson:** No current service.
  - **Recommended Improvements:** Direct peak only service between Southeast area Downtown Tucson; supported by new park-and-ride lot in Rita Road/I-10 vicinity.
• **Shuttle service in Southeast Industrial Area:** No current service.
  - **Recommended Improvements:** Implement new network of shuttle buses operating from vicinity of TIA to various locations in the Southeast Industrial area; the shuttle routes will be connected with express bus service. Supported by transit hub in area of TIA to allow convenient connections with express bus services. To the right is a photo of vehicles used to connect the Microsoft corporate campus (Redmond, WA) with a nearby transit center/park-and-ride lot.

**New Limited Stop/Overlay Service**

The urban area of the Tucson region has an extensive network of transit routes, with many operating on major arterials. With few exceptions (e.g., Route 82 on Broadway), all routes serve each stop thereby making the trip, particularly for those starting at the outer edges of the routes, very long for many users. This means that public transit cannot compete with travel times of the private auto for trips exceeding three miles in length.

With limited service, most stops are skipped with the result being an overall quicker ride for customers. This limited-stop feature is sometimes a major component of bus rapid transit (BRT) systems, which are further described in Section 3 of this Technical Memorandum. The provision of limited service can provide a key building block for more extensive HCT development such as BRT or light rail transit.

The limited/skip stop service is identified for seven major HCT corridors that were identified in Phase 2 of the Transit Element.

1. **Speedway:** Currently local service only on Route 4; all stops are currently served.
   - **Recommended Improvements:** “Skip stop” overlay service on Speedway in peak periods between Harrison and Downtown Tucson; supported by signal preemption and queue jumps.

2. **Broadway:** Primarily local access only; served by local Route 8 and Route 82—Broadway Express
   - **Recommended Improvements:** Expanded limited stop service between Speedway/Harrison park-and-ride and Downtown Tucson; supported by signal preemption and queue jumps.

3. **Sixth Street:** Currently local access only; all stops are served.
   - **Recommended Improvements:** “Skip stop” overlay service in peak periods on Sixth/Wilmot/Stella between PCC East and Downtown Tucson.

4. **Campbell:** Currently local access only on Route 15—all stops are served; service operates between Tucson Mall and University of Arizona.
   - **Recommended Improvements:** “Skip stop” overlay service in peak periods on extended Campbell/Kino Parkway coverage between Cortaro Farms Road, Tucson Mall, University of Arizona, and TIA; supported by signal preemption and queue jumps.
5. **6th Avenue**: Currently local access only; all stops are currently served.
   - **Recommended Improvements**: “Skip stop” overlay service in peak periods on 6th Avenue between Laos transit center Downtown Tucson; supported by signal preemption and queue jumps.

6. **Houghton Road**: No service.
   - **Recommended Improvements**: “Skip stop” overlay service in peak periods on Houghton Road between new SE transit center (Rita Ranch area) and Speedway; supported by signal preemption and queue jumps.

7. **Anklam/St Mary’s**: Local service only; all stops are currently served.
   - **Recommended Improvements**: “Skip stop” overlay service in peak periods between Pima College West and Downtown Tucson/University of Arizona; supported by signal preemption and queue jumps.

8. **Alvernon**: Currently local access only; all stops are currently served.
   - **Recommended Improvements**: “Skip stop” overlay service in peak periods between River Road and Tucson International Airport; supported by signal preemption and queue jumps.

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**Old Pueblo Trolley Extension to Rio Nuevo**

The City of Tucson is currently planning for the extension of the Old Pueblo Trolley (OPT) line into downtown to terminate next to the Intermodal Depot Center. This will be achieved once the 4th Avenue Underpass is constructed and new trolley tracks are put in place. However, there are bigger plans to extend the trolley line into the future Rio Nuevo development, located on the western edge of downtown. A preferred alignment involves Congress, Pennington, and Toole.

As part of Alternative 2, it is recommended that the OPT route be extended 1.5 miles through downtown to a terminus within the Rio Nuevo development, most likely located close to Interstate 10 (I-10). This project will include, track extension for two-way operation, overhead electric and pole installation, trolley stop enhancements, a new maintenance/operations facility, construction of a small station within Rio Nuevo, renovation of trolley vehicles, and additional trolley vehicles. Regular service by trolleys will be operated seven days per week with increased frequencies provided in peak periods.

**Capital–Related Recommendations under Alternative 2**

The capital program for Alternative 2 includes additional modern, low-floor vehicles to support new express and limited stop service. Recommendations also call for new facilities such as parking-and-ride lots, Intelligent Transportation Systems (ITS), signal preemptions, queue jumps, and extension of the Old Pueblo Trolley to Rio Nuevo. The queue jumps are included in Alt 2 since they support the emphasis on faster and more reliable transit services.

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3 City of Tucson Department of Transportation.
New Park-and-Ride Lot Development

The park-and-ride lot service identified in the previous section is estimated to support about 1,800 park-and-ride spaces. The park-and-ride lot development (average size of 300 spaces) is identified at the following general locations:

- Oro Valley (1st Avenue/Oracle Road; 600 spaces serving two express routes or two 300-space park-and-ride lot lots)
- Marana (Cortaro Farms Road/I-10)
- Northeast Area (either new lot in area of Harrison/Tanque Verde or expansion of existing lot at Speedway/Harrison)
- Sahuarita/Green Valley (I-19/Sahuarita Road)
- Houghton Road/Southeast Tucson Area (Rita Road/I-10)

For planning purposes, the cost per park-and-ride space is estimated at $10,000. This cost per space is comparable to the costs at the new park-and-ride lot in Phoenix (40th Street and Pecos Road). This facility, with 562 spaces, had a total construction cost of about $5.1 million. It includes covered parking for most of the spaces, a security guard building, bike lockers/racks, and other features. The unit cost estimates for new park-and-ride spaces in the Tucson area should take into consideration construction of parking spaces plus items such as access roads, passenger facilities, and any necessary environmental remediation. The park-and-ride lots should also include features such as covered parking, all-day security presence, and secure bicycle storage areas.

The park-and-ride lots also should be planned in a manner that will encourage potential joint-use development such as housing. This joint-use can help spread costs among multiple agencies and the private sector. In some existing park-and-ride lot in the US, relatively small developments such as police substations and offices for a transportation management agency have been built. Joint uses involving the public sector can include provisions of amenities such as coffee shops and dry cleaners. The photo to the right shows a building in a suburban Seattle park-and-ride lot that houses an operations center for an employee shuttle service. The shuttle serves a nearby office park.

New Transit Center near Tucson Airport/Southeast Industrial Area

To support the new express service and shuttle operations in the TIA/Southeast industrial area, a new transit center is identified. This center will allow convenient transfers between the express routes and shuttle service that will access various employment sites in the industrial area.
**Transit Priority Treatments**

Various signal priority and queue jump improvements are recommended along major arterials that will have limited stop overlay service. Other arterials with local service only also will benefit from these types of improvements. A detailed study will need to be carried out to identify specific locations and appropriate priority treatments.

For planning purposes, transit priority treatment costs include approximately $100,000 for each major corridor. This type of treatment can be anticipated for major arterials such as Speedway, Campbell, Sixth Street, Oracle Road/6th Avenue, and Houghton Road. A total of eight transit corridors have been identified for this type of improvement. These correspond to the eight corridors identified in this alternative for limited/skip stop service. Using automatic vehicle location technology, the precise location of buses can be determined in a real-time manner. If the buses are running behind schedule, traffic control systems along the affected corridor can extend or trigger green time at signals.

Bus pull-outs and queue-jump lanes allow for the smooth flow of traffic in the outside lane along major roadway corridors. Recommendations call for the continued construction of these facilities at all stops where there is substantial boarding activity and dwell-time, particularly at major intersections. For costing purposes, 50 total potential queue jump installations have been identified.

A study of all stops should be conducted to identify exactly where pull-outs are needed to improve traffic flow without compromising transit service efficiency. Improvements should be closely coordinated with all future roadway corridor projects, as well as potential high-capacity transit corridors identified in Technical Memorandum 2.

This type of priority treatment can be anticipated along the same arterials identified above. For planning purposes, five potential locations along each of the nine HCT corridors are called out for queue jump development. Five additional queue jumps are identified for non-HCT locations. Locations of the queue jumps should be determined through more detailed study. Costs for the queue jump could be significant if utility re-location, and other cost-intensive items are required.

**Old Pueblo Trolley Extension to Rio Nuevo**

The facility and vehicles elements of the Rio Nuevo rail extension involve the following:

- Double tracks for the entire alignment
- New maintenance facility at south end of the alignment
- Total fleet size: 17 vehicles (including spares and three units for special events)

Per the Draft Rio Nuevo Transit Analysis, the extension of trolley tracks and other associated costs are estimated at $22.2 million. Of this total, $4.5 million is estimated for additional cars. These costs will be incorporated in the overall cost estimate for Alternative 2.

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4 Per estimate by City of Tucson staff for signal priority treatment along Broadway.

5 Draft Rio Nuevo Transit Analysis (March 2001).
Alternative 3—Aggressive Efforts to Expand High-Capacity Transit Service

Alternative 3 builds upon the successful implementation of Alternatives 1 and 2 by aggressively pursuing further expansion of transit services, especially HCT. Major HCT improvements will take place in corridors where demographics, land use policies, and recommendations from previous corridor studies provide support for the improvements.

Alternative 3 also looks at potential improvements relating to inter-city rail service. This includes identifying key factors that need to be considered for any major inter-city rail service from Tucson to both Phoenix and Nogales.

Selected HCT Corridors (from Phase 2 of the Transit Element)

The Transit Element of the Regional Transportation Plan recommends HCT system development for the nine corridors identified in Technical Memorandum No. 2. While many of these improvements will be implemented in Alternatives 1 and 2, Alternative 3 calls for aggressive improvements such as bus rapid transit (BRT) or light rail transit (LRT) development affecting the following corridors:

- **Oracle Road/6th Avenue**: The Oracle Road/6th Avenue corridor included two of the previously identified HCT corridors—Oracle Road to Downtown Tucson and Downtown Tucson to Irvington.

- **Broadway/Speedway/Sixth Street**.

Further HCT improvements along two other HCT corridors, I-19 and I-10, can take the form of improved transit-only access such as direct access ramps connecting park-and-ride lots and freeways. These improvements are presented in this section under the capital program for Alternative 3. Improvements along these corridors can also include potential bus-only lanes. Actual determination of constructing these bus-only lanes should be addressed in the road-related efforts for the 2030 Regional Transportation Plan and the Arizona Department of Transportation’s Long-Range Transportation Plan.

For the remaining HCT corridors, the University of Arizona-Rio Nuevo trolley extension was identified in the recommendations under Alternative 2. Anklam/Sixth Street and Houghton Road HCT improvements could be incorporated as extensions of BRT/LRT for the Broadway/Speedway/Sixth Street Corridor. Determination should be made through the City of Tucson’s Alternatives Analysis that will be carried out starting in late 2003. Improvements along Campbell could involve BRT or LRT at some future point but the land use growth and travel demand patterns indicate that the two selected corridors are more appropriate for either BRT or LRT development.

Overview of Light Rail Transit and Bus Rapid Transit

LRT provides high capacity rail service using a variety of right-of-way (ROW) configurations. While some LRT systems have a portion of their alignment in tunnels or other separate rights-of-way, many involve use of streets, including those in central business districts. This flexibility of operations and resulting lower construction costs (versus heavy rail systems such as the Bay Area Rapid Transit System in the San Francisco region) made LRT a preferred option for many transit systems in the U.S. and Canada starting in the late 1970s and continuing through today.
LRT systems operating in North America involve a variety of operating configurations. Some of the first new systems such as those in Edmonton, Canada and San Diego used former railroad ROW. While many systems operating in downtown areas make use of existing streets (San Jose, Salt Lake City), others required expensive tunnel construction (Los Angeles Blue Line and Seattle Central LINK). Under any of the operating configurations, LRT systems are characterized by a limited number of passenger stations. This results in LRT vehicles reaching significantly higher speeds than conventional buses. The spacing of stations (mean distance between stations) can vary from about 1,600 feet in Philadelphia to more than 1 mile in San Diego and Los Angeles.

BRT is a relatively new concept in high-capacity transit. While it is sometimes presented as a lower cost option to LRT, it is intended to have some of the key features of rail service such as higher speeds (versus regular bus service), modern low-floor buses, preferential treatment at traffic signals, possibly its own ROW on streets, more comfortable passenger facilities, and a generally higher level of visibility compared to conventional bus service.

BRT can have its own ROW; however, existing systems in North America show a wide variety of operating configurations. BRT systems in Ottawa and Pittsburgh operate in exclusive bus lanes with extensive station development. Other systems such as new RAPID express bus in Phoenix (I-10 and State Route 51) and the Silver Line in Boston use exclusive bus lanes on freeways or major streets. Several recent applications of BRT have limited or no exclusive ROW for bus operations. The Wilshire Boulevard and BRT line in Los Angeles County does not have an exclusive bus lane. But signal treatments and other features along the corridor have resulted in reduced travel time for buses. The BRT line connecting Downtown Vancouver, BC and the City of Richmond, BC Town Center has an exclusive bus lane along 1.6 miles of its 10-mile alignment.

Higher level of visibility by BRT can include different and usually bolder color and graphics schemes, distinctly designed bus stops that include real time information on arriving buses as well as other features. Added features such as a distinctive design and use of new colors result in the BRT stops taking on the look and feel of a station. These stations have been a key component of BRT in several recently implemented systems such as the Los Angeles Wilshire and Ventura lines, the B-Lines in Vancouver, and the RAPID bus in Phoenix.

**Basis for Selecting BRT/LRT Corridors**

The corridors for either BRT or LRT improvements were selected for the following reasons.

**Broadway/Speedway/Sixth Street Corridor**

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6 _Wilshire Bus Rapid Transit—More than Just a Dedicated Bus Lane_ (Transportation Research Board Annual Meeting 2003, Nicholas Papandreou, Los Angeles County Metropolitan Transportation Authority).
In the early 1990s, a study was conducted to identify potential HCT development opportunities along Broadway. While this study did not recommend rail transit development (based on ridership forecasts), developments and travel along the corridor have grown and future major growth is expected to occur.

- Bus priority treatment in the form of dedicated lanes has already been implemented on Broadway; it also has more than 8 miles of existing shared bus lanes (buses only plus right turns) on various segments of the corridor, which lay the groundwork for future completion of the corridor to accommodate high-capacity transit service.

- Major land use densities exist along Broadway, including high concentrations of commercial and mixed use developments built in recent years.

- Overall travel growth in the general corridor will be expected to be substantial due to continued growth in the east and southeast areas of Tucson, and growth of the University of Arizona campus.

- There are several major generators along this corridor such as Downtown Tucson and the University of Arizona.

- Bus routes serving this corridor experience significant ridership generated by activities along the route and via transfers from several major north-south lines.

Oracle Road/6th Avenue Corridor

- This north-south corridor connects major generators and attractors such as Oro Valley, Tucson Mall, Downtown Tucson, and 6th/12th Avenue to South Tucson, TIA, and the Southeast Tucson Industrial area.

- Existing demographic features as well as current and estimated land use densities along portions of the corridor indicate a strong market for transit.

- The corridor also is expected to experience major growth in population, employment, and resulting travel demand over the next few decades.

- Portions of this corridor experience the highest bus ridership levels in the region.

- Redevelopment in the Flowing Wells area is identified by the Pima County Comprehensive Plan.

- Oracle Road experiences some of the highest traffic volumes among arterials in the region.

Service Recommendations under Alternative 3

Under Alternative 3, each of the service recommendations identified in Alternatives 1 and 2 will be included. In addition to these improvements, either BRT or LRT improvements are called out for two selected corridors. The following are service-related recommendations for these improvements.

Corridor Improvements

Broadway/Speedway/Sixth Street: The limits of this corridor are Downtown Tucson on the west and Houghton Road on the east. Travel along the Houghton Road corridor will grow significantly due in part to the expected major growth in Southeast Tucson. Along this corridor service should be provided to the University of Arizona campus. The campus is expected to grow significantly and limitations relating to on-campus parking growth will mean greater reliance on alternative modes such as public transportation.
Oracle Road/S 6th Avenue: The limits of this corridor include the general area of Oracle Road and 1st Avenue in the north and the TIA/Southeast Industrial Area to the south. Table 3 identifies key service characteristics for both BRT and LRT under Alternative 3 while Figure 3 illustrates the location of these elements. Recommendations for major HCT development are identified for either BRT or LRT along two corridors: Oracle Road/6th Avenue and the Speedway/Sixth Street/Broadway corridor.

Table 3
Summary of Potential BRT/LRT Service Characteristics under Alternative 3

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Headways (hours)</th>
<th>Service Span (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Peak</td>
<td>Midday</td>
</tr>
<tr>
<td>Broadway/Speedway</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Sixth St</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oracle Rd/S 6th Ave</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>

With the implementation of either BRT or LRT along the two identified corridors, some reduction in current service levels on local routes could be expected. The following identifies these reductions:

- Broadway/Speedway/Sixth Street Corridors
  - Reduce bus frequencies on one of the major streets within the corridor
  - Eliminate one of the limited stop services as recommended in Alt 2
- Oracle Road/S 6th Avenue
  - Reduce bus frequencies on one of the major streets within the corridor
  - Remove peak overlay service on S 6th Avenue (overlay recommended in Alternative 2)
  - Remove the express route from Oro Valley to the Southeast Tucson Industrial Area (overlay recommended in Alternative 2)

Final determination of the appropriate mode for either corridor should await the alternatives analysis effort that will be undertaken by the City of Tucson starting in late 2003. However, as noted above, existing and projected growth rates affecting these two corridors indicate a more extensive level of HCT improvements involving both service and facilities, than what has been determined for the other seven HCT corridors.

It is also possible to have different alignments and configuration of the either BRT or LRT affecting the two corridors. These could be a T-shaped configuration resulting in both corridors being affected. Another variation can involve L-shaped alignment that could for example consist of the Broadway/Speedway/Sixth Street corridor and the Downtown Tucson/Southeast Tucson Industrial area component of the Oracle Road/S 6th Avenue corridor.
Figure 3
Alternative 3 - Recommended Major Improvements (In Addition to Improvements Identified in Alternatives 1 and 2)

Transit Element / 2030 RTP

= NEW DIRECT ACCESS RAMPS
'= BRT OR LRT DEVELOPMENT

The Transpo Group

M10202229114 - Service Fac Imp Maps/Graphic03.cdr (C)
**Other Key Features of BRT/LRT Improvements**

Other recommended features of BRT or LRT services are as follows:

- **Station Spacing**: Stations should be spaced in a manner that allows vehicles to operate at higher speeds than conventional bus service.

- **Station Features**: BRT and LRT stations should have passenger conveniences such as real time information route maps, bicycle storage, seating areas, and lighting.

- **LRT Vehicles**: Modern, low-floor vehicles should be provided with vehicles operating in trains. The usual train size ranges from two to four vehicles with their overall length limited in part to block lengths.

- **Transit Operations**: Vehicles should be given priority treatments using state-of-the-art ITS technology. This should be done without significant negative impacts on general traffic along the corridors or along affected cross-streets.

Before LRT or BRT is selected for the two major HCT corridors, several factors need to be considered. These factors attempt to address some major issues that have been raised in the current debate involving the respective merits and potential drawbacks of LRT and BRT. These factors include the following:

- **Costs and Associated Affordability**: There can be substantial cost variations between BRT and LRT; however, this variation for the most part relates to the potential capacity that each mode can provide.

- **Potential Daily Ridership**: LRT may have an advantage in terms of ridership potential. Daily ridership for BRT ranges from 7,000 to 15,000 while the range for LRT is between 7,000 and 57,000 boardings\(^7\). Thus, additional LRT costs for vehicles signal systems, overhead wires reflect the ability to provide higher capacity. It also needs to be kept in mind that some overlap in capacity occurs between what BRT and LRT can provide.

- **Impacts on Overall Mobility**: BRT and LRT will likely involve surface operations along the affected corridors. While transit priority treatment is recommended for either mode, this should be done without significantly impacting general traffic.

- **Impacts on Land Use**: Both BRT and LRT can greatly influence future land use development around station areas. LRT has some advantages since it provides potentially higher people-carrying capacity, overall visibility, and permanence as compared to BRT.

- **Environmental Benefits and Impacts**: For any specific BRT or LRT improvement, environmental assessment will need to be carried out if federal funds are being pursued.

- **Implementation**: In general, BRT can be implemented quicker than LRT due to lack of necessary track, overhead wires, electrical substations, etc. For example, RAPID bus service in Phoenix was implemented in July 2003. It was part of the transit package approved by voters in March 2000. Thus, the implementation period was a little more than three years.

- **Phasing of HCT**: BRT can serve as a first phase of major HCT development. As demand grows, it can lead to LRT development. One example is the 98 B-Line in Vancouver, British Columbia. This is currently a BRT route but the regional transit

---

\(^7\) Mass Transit: Bus Rapid Transit Shows Promise; US General Accounting Office (September 2001).
The authority in Vancouver has decided to proceed with LRT development along the corridor.

Capital–Related Recommendations under Alternative 3

Recommendations under Alternative 3 will include major high-capacity transit development along the two identified BRT/LRT corridors as well as along selected express corridors in the region. These improvements will be in addition to the capital-related recommendations called out in Alternatives 1 and 2.

BRT/LRT Improvements

For both BRT and LRT developments, key cost items include major HCT infrastructure development such as:

- Rail lines for LRT
- Dedicated lanes for BRT
- Station developments
- Required maintenance and operations facilities
- Possible ROW requirements
- Corridor upgrades such as signal prioritization

In the costing assessment included in this Technical Memorandum, per-mile unit costs for construction were assumed using information from the U.S. Government Accounting Office Report on Bus Rapid Transit. These costs are as follows:

<table>
<thead>
<tr>
<th></th>
<th>BRT</th>
<th>LRT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$9.0 million</td>
<td>$34.8 million</td>
</tr>
</tbody>
</table>

The above costs are being used for planning purposes only in order for BRT and LRT improvements to be included in the overall capital program for Transit Element alternatives. Variations around the assumed average per mile cost can be attributed to a variety of factors such as possible property taking, need for structures, and environmentally-related mitigation efforts. More precise estimates of costs for these improvements will require more detailed engineering and environmental assessment.

For planning purposes, operating costs per hour were based on an average of several transit systems as called out by the GAO report on Bus Rapid Transit. These ranges are:

<table>
<thead>
<tr>
<th></th>
<th>BRT</th>
<th>LRT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$100/hour</td>
<td>$200/hour</td>
</tr>
</tbody>
</table>

The higher hourly costs for LRT include a variety of factors such as maintenance and operations for rail and signals as well as larger stations versus those for BRT. Also, in most cases maintenance and operations for BRT are not identified as a cost item since these are included in total roadway maintenance and operations costs for the affected jurisdictions. As is the case with other elements of the recommended service and facility program, more detailed estimates of operating costs for will require identification and assessment of potential BRT and LRT characteristics.
**Express Service Improvements**

Alternative 3 will also include items for other HCT corridors such as I-10 and I-19 that have upgraded express service. Examples included direct access ramps connecting park-and-ride lots and bus lanes on major freeways/arterials.

Provision of these direct access ramps can substantially improve the speed and reliability of express bus service operating in the region. The following highlight major benefits of these improvements:

- With the direct access ramps, buses avoid local traffic in the vicinity of the park-and-ride lots.
- Local traffic is benefited by reduced bus volumes concentrated in a small area including freeway ramps.
- Overall bus operating time is reduced along with resulting costs.
- Direct access projects provide an opportunity for joint efforts between transit operators and Arizona Department of Transportation. In the Puget Sound area, staff at the Washington Department of Transportation led design efforts for several direct access ramp projects.

Figure 4 shows an example of a direct access ramp under development in Snohomish County, Washington. This project is a variation of the Texas T direct access ramps developed by the Texas Department of Transportation in the Houston area.

**Estimated Costs of Transit Element Alternatives**

Table 4 identifies summary information costs for Alternatives 1, 2, and 3. These costs are in addition to existing baseline costs of transit service in the Tucson region. The baseline costs are from the FY 2002 information that was identified in Phase 1 of the RTP Transit Element. Costs are identified in 2003 dollars and do not account for inflation.

Both operating and capital costs are identified and broken out by major category. The major factors driving the various cost items are identified in a series of tables included in Appendix A. These tables (two for each alternative) identify major service and capital characteristics that determine costs items. For example, features for new express service (e.g., headways during peak periods and bus travel time) determine the volume of required additional vehicles. As the Transit Element goes through further review and necessary changes are made (e.g., revised headways on express routes), revisions to related costs items can be done automatically.

The following summarizes major cost items under each alternative.

**Alternative 1—Emphasis on Transit Dependent**

Total operating costs under this alternative will increase by almost 80 percent over baseline (2002) levels. Among the new services recommended under Alternative 1, the expanded paratransit services item is the largest at $8.4 million per year. This is followed closely by the cost of congestion item at $8.1 million. Other major service cost items include New Neighborhood Services ($4.3 million), Frequency Improvements ($3.6 million), New Local Routes ($3.4 million), and Service Period Extensions ($2.2 million).
Figure 4. New Direct Access Ramp (Snohomish County, WA)
## Table 4
Summary Information on Operating and Capital Costs - Transit Element Alternatives

<table>
<thead>
<tr>
<th>Cost Elements</th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Costs</strong> Baseline (2002)</td>
<td>$40,400,000</td>
<td>$40,400,000</td>
<td>$40,400,000</td>
</tr>
<tr>
<td><strong>Additional Annual Operating Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency Improvements</td>
<td>$3,643,860</td>
<td>$3,643,860</td>
<td>$3,643,860</td>
</tr>
<tr>
<td>Service Period Extensions</td>
<td>$2,203,743</td>
<td>$2,203,743</td>
<td>$2,203,743</td>
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<tr>
<td>Weekend Service Improvements</td>
<td>$978,450</td>
<td>$978,450</td>
<td>$978,450</td>
</tr>
<tr>
<td>Service Area Extensions - Existing Routes</td>
<td>$1,495,120</td>
<td>$1,495,120</td>
<td>$1,495,120</td>
</tr>
<tr>
<td>New Local Routes</td>
<td>$3,359,015</td>
<td>$3,359,015</td>
<td>$3,359,015</td>
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<tr>
<td>Cost of Congestion</td>
<td>$8,080,000</td>
<td>$8,080,000</td>
<td>$8,080,000</td>
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<tr>
<td>New Neighborhood Services</td>
<td>$4,333,725</td>
<td>$4,333,725</td>
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<td>Expanded Paratransit Services</td>
<td>$8,383,000</td>
<td>$8,383,000</td>
<td>$8,383,000</td>
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<tr>
<td>Expanded Vanpool Services</td>
<td>$400,000</td>
<td>$400,000</td>
<td>$400,000</td>
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<tr>
<td>New Express Service</td>
<td>$4,417,875</td>
<td>$4,417,875</td>
<td>$4,417,875</td>
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<tr>
<td>New Limited Stop/Overlay Service</td>
<td>$2,875,125</td>
<td>$2,875,125</td>
<td>$2,875,125</td>
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<tr>
<td>Rio Nuevo Trolley Extension</td>
<td>$965,000</td>
<td>$965,000</td>
<td>$965,000</td>
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<tr>
<td><strong>Total Additional Annual Operating Costs - Potential New Services</strong></td>
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<td>$41,134,913</td>
<td>$51,026,913</td>
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<tr>
<td><strong>Capital Costs (Cumulative)</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Additional Vehicles</strong></td>
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</tr>
<tr>
<td>Frequency Improvements</td>
<td>$10,150,000</td>
<td>$10,150,000</td>
<td>$10,150,000</td>
</tr>
<tr>
<td>Service Area Extensions - Existing Routes</td>
<td>$2,100,000</td>
<td>$2,100,000</td>
<td>$2,100,000</td>
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<tr>
<td>New Local Routes</td>
<td>$4,900,000</td>
<td>$4,900,000</td>
<td>$4,900,000</td>
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<tr>
<td>New Neighborhood Services</td>
<td>$3,930,000</td>
<td>$3,930,000</td>
<td>$3,930,000</td>
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<tr>
<td>Replacement buses (for expanded fixed route service: Alt 1)</td>
<td>$21,080,000</td>
<td>$21,080,000</td>
<td>$21,080,000</td>
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<tr>
<td>Expanded Paratransit Services</td>
<td>$6,682,000</td>
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<tr>
<td>Expanded Vanpool Services</td>
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<tr>
<td>New Express Bus Service</td>
<td>$44,634,000</td>
<td>$44,634,000</td>
<td>$44,634,000</td>
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<tr>
<td>New Limited Stop/Overlay Service</td>
<td>$44,634,000</td>
<td>$44,634,000</td>
<td>$44,634,000</td>
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<tr>
<td>Rio Nuevo Trolley Extension</td>
<td>$3,780,000</td>
<td>$3,780,000</td>
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<tr>
<td><strong>Subtotal Vehicle Costs</strong></td>
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<td>$142,070,000</td>
<td>$142,070,000</td>
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<tr>
<td><strong>Facility Improvements</strong></td>
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<tr>
<td>New Transit Centers to Support Neighborhood Services</td>
<td>$7,000,000</td>
<td>$7,000,000</td>
<td>$7,000,000</td>
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<tr>
<td>New maintenance/operations base in NW area</td>
<td>$27,700,000</td>
<td>$27,700,000</td>
<td>$27,700,000</td>
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<tr>
<td>Expanded maintenance/operations capacity for paratransit</td>
<td>$10,000,000</td>
<td>$10,000,000</td>
<td>$10,000,000</td>
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<tr>
<td>Improved sidewalk connections/bus stops</td>
<td>$10,000,000</td>
<td>$10,000,000</td>
<td>$10,000,000</td>
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<tr>
<td>Real-time information at transit centers/major bus stops</td>
<td>$2,500,000</td>
<td>$2,500,000</td>
<td>$2,500,000</td>
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<tr>
<td>Minor upgrades to existing park-and-ride lot lots</td>
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<td>$1,000,000</td>
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<tr>
<td>Additional Park-and-ride Spaces</td>
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<td>$18,000,000</td>
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<td>$1,000,000</td>
<td>$1,000,000</td>
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<tr>
<td>Signal Priority Treatment</td>
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<tr>
<td>Rio Nuevo Trolley Extension</td>
<td>$18,420,000</td>
<td>$18,420,000</td>
<td>$18,420,000</td>
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<tr>
<td>Bus pull-puts and queue jumps</td>
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<td>$5,000,000</td>
<td>$5,000,000</td>
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<tr>
<td><strong>Subtotal Facility Costs</strong></td>
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<td>$101,420,000</td>
<td>$101,420,000</td>
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<tr>
<td><strong>Major HCT Investments</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Major High Capacity Transit - Speedway/Broadway BRT</td>
<td>$117,000,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LRT</td>
<td></td>
<td>$452,270,000</td>
<td></td>
</tr>
<tr>
<td>Major High Capacity Transit - Oracle/6th Avenue BRT</td>
<td>$198,000,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LRT</td>
<td></td>
<td>$765,380,000</td>
<td></td>
</tr>
<tr>
<td>New Direct Access Ramps at Park-and-ride Lots</td>
<td>$110,580,000</td>
<td>$110,580,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total Major HCT Investments</strong></td>
<td>$425,580,000</td>
<td>$1,228,230,000</td>
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</tr>
<tr>
<td><strong>Total Capital Costs</strong></td>
<td>$107,222,000</td>
<td>$243,490,000</td>
<td>$669,070,000</td>
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</table>

**HCT Cost Range**

<table>
<thead>
<tr>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10,150,000</td>
<td>$452,270,000</td>
</tr>
<tr>
<td>$198,000,000</td>
<td>$765,380,000</td>
</tr>
<tr>
<td>$110,580,000</td>
<td>$1,228,230,000</td>
</tr>
</tbody>
</table>
For the capital program, additional vehicles required to improve service frequencies dominate at $10.2 million. The additional capacity for expanded paratransit fleet also will be significant at $10.0 million. While new transit centers recommended in the alternative will incur $7.0 million, a higher level of costs ($10.0 million) will be incurred by improvements to sidewalks and bus stop.

**Alternative 2—Emphasis on Transit Choice Market**

Total operating costs under this alternative would nearly double over baseline (2002) levels. As is the case with Alternative 1, expanded paratransit services item is the largest item at $8.4 million per year. This is followed closely by the cost of congestion item at $8.1 million. The New Express routes will incur about $4.4 million in additional annual costs while New Limited Overlay service will incur $2.9 million.

Major capital items under Alternative 2 include buses for New Express Service ($27.5 million), buses for New Limited Stop Service ($17.2 million), and Expanded Paratransit Service ($6.9 million). Costs for facility improvements are dominated by additional park-and-ride lot spaces ($18.0 million) and the Rio Nuevo Trolley Extension ($18.4 million for facility development).

**Alternative 3—Aggressive Efforts to Expand High-Capacity Transit**

Under this Alternative, additional service improvements involve BRT or LRT. Combined with the other service expansion that will take place under this alternative, additional annual operating costs could be over 130 percent of baseline levels. In Table 4, a range of costs are identified for the additional services. The Low additional annul operating costs involve BRT with a per-hour cost level of $100 per hour. The High additional annual costs for LRT are at $200 per hour.

The additional BRT services for the Broadway/Sixth Street/Speedway and Oracle Road/ S 6th Avenue would make up about 19 percent of total additional transit services under Alternative 3. However, if the scenario involving LRT service is implemented, these costs will be about 24 percent of total additional transit service costs. The capital cost items under Alternative 3 also use a cost range depending on whether BRT or LRT are used. Under the low-cost scenario, the additional improvements for BRT ($315 million) will make up about 47 percent of total additional capital costs under Alternative 3. For the high cost scenario, the LRT construction ($1.2 billion) would make up about 77 percent of all additional capital costs for Alternative 3.

**Intercity Rail Development**

With the recommended transit service and facility improvements identified in each of the Transit Element alternatives, it also will be important for the Tucson region to have high quality access to other major locations in Arizona, particularly Phoenix and Nogales. The City of Tucson will be looking at the Tucson-Nogales rail corridor as part of study to be done in FY 2003–2004. For both corridors, existing rail lines provide an opportunity for upgraded rail service. More
detailed studies will need to be undertaken before any definition of required items and related costs. This will require joint cooperation between several local, regional, and state agencies with a shared interest in rail service.

Key improvements that need to be considered are grade-separated interchanges at major roadway crossings, double-tracking, new signalized crossings, fencing along corridors, and construction of a new Y-connection between the main line and the Nogales spur line just east of downtown.

Planning efforts for inter-city rail should also consider vehicles that take advantage of new technology development. One example is the development of diesel multiple unit (DMU) vehicles for operations on freight rail corridors. These vehicles do not require a locomotive to power it or overhead wires, thus reducing overall capital costs.
4. Supporting Strategies for Transit Element Recommendations

The extent of service and facility improvement proposed under any of the Transit Element alternatives represents a major change in direction within the Tucson region. It will be in contrast to recent local cuts in service by Sun Tran, the regional largest provider. Many of the service and facility recommendations under the alternatives involve multi-jurisdictions. Also, the extent of additional costs associated with each alternative will require additional revenues that are likely beyond the funding capabilities of local jurisdictions in terms of general fund support.

Given the institutional implications of the recommendations, the Tucson region should examine options as to how transit planning, funding, and operations should be carried out. This section presents three possible scenarios that can be considered, including pros and cons for each.

The section also provides some direction regarding support from agencies and the private sector for the implementation of alternatives.

Governance of Transit Planning, Service, and Financing

Option 1—Status Quo
- No institutional changes.
- More extensive coordination of planning, information sharing.
- Any new/upgraded inter-city services will have to be handled through Inter-Governmental Agreements (IGAs).

Option 2—New Authority for Regional Services/Planning
- Modeled after Valley Metro (formerly Regional Public Transportation Authority) in Phoenix.
- Provides a formal regional approach and image to planning and operations while also allowing local cities to plan/operate their systems.
- As is the case with Valley Metro, membership requires commitment of a portion of Local Transportation Assistance Funds (LTAF) to transit.
- Nineteen cities are currently members of Valley Metro; the extent of membership could present issues relating to decision-making.
- There is some maintenance of local autonomy for planning/operations.

Option 3—Consolidation of All Transit Systems
- New authority responsible for all transit planning, operations, and funding.
- Makes it easier to plan/monitor and operate all systems.
• Single voice with state and federal agencies as well as private sector (e.g., railroads relating to inter-city services).
• Loss of local autonomy for planning/operations.

Potential Support from Public Agencies and the Private Sector
The following are areas involving potential support for the recommendations called out in the Transit Element alternatives.

Support for Land Use Policies
• Commitment of staff that work with transit planners (e.g., outreach for transit oriented development).
• ADOT resources for park-and-ride lot development and other capital items (e.g., direct access ramps).
• At the University of Arizona campus, implementation of the Comprehensive Campus Plan can provide major support for future transit service development. It will be particularly important to look at pricing policies for on-campus parking and even remote parking.
• Commitment in local plans for supporting transit facilities (e.g., at new developments near interchanges, set asides for park-and-ride lot capacity).

Coordination with Roadway Development
• Include consideration of transit improvements in roadway design guidelines.
• Coordinate transit improvements with corridor studies and roadway improvement projects.
• Possible transit improvements include bus pull-outs along major arterials, intelligent transportation systems coordinated with road-related strategies, and park-and-ride lot development that can be carried out with future highway and road widening.

Private Sector Support
• Participation by private bus operators in planning for new transit centers (these facilities can be used by private carriers for inter-city/airport shuttle service).
• Potential joint-use development at new park-and-ride lot/transit centers; this can be done with local agencies.
• Considerations of any potential joint use development at transit centers or park-and-ride lots should take place early in the process to incorporate potential uses in the overall design of the facilities as well as potential funding support.
Appendix A

Cost Estimates for Service and Capital Improvements
<table>
<thead>
<tr>
<th>Service Component</th>
<th>Affected Service</th>
<th>Existing Service Features</th>
<th>Recommended Service Features</th>
<th>Facilities</th>
<th>Other</th>
<th>Cost Details</th>
<th>Operating and Capital Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtotal - Frequency Improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Period Extensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal - Service Area Extensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Route Extensions</td>
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<td>Subtotal - New Routes</td>
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</tr>
<tr>
<td>Total - Traditional Fixed Route</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacement vehicles (for expanded service)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
### Service Component

**Affected Service**

- NW Area - Circulator/Oro Valley
- NW Area - Circulator/Oro Valley
- NW Area
- NW Area
- NW Area
- NE Area
- NE Area
- SE Area
- SW Area
- Industrial Area
- SW Area
- SE Area
- Industrial Area
- Industrial Area
- Industrial Area
- Industrial Area
- Ajo Highway/Pasqua Yaqui
- SE Area

### Existing/Recommended Service Features

- **Existing Operations**
  - Coyote Run (utility & donated)  
- **Recommended Changes**
  - Expanded neighborhood circulator for general public (per adopted COT for Oro Valley)
- **Additional Vehicle(s) (includes spare factor)**
  - 2 (needs for transit center in area of Oracle Road and the Avenue)
- **Unmet Needs**
  - 17,000
- **Operating and Capital Costs**
  - Existing/Recommended Service
  - Capital Improvements

### Vehicle Costs Facility Cost Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit Cost</th>
<th># of Locations</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>30' minibus</td>
<td>262,000</td>
<td>100</td>
<td>26,200,000</td>
</tr>
<tr>
<td>40' bus</td>
<td>350,000</td>
<td>100</td>
<td>35,000,000</td>
</tr>
<tr>
<td>Surplus vehicles</td>
<td>76,000</td>
<td>100</td>
<td>7,600,000</td>
</tr>
<tr>
<td>Paratransit</td>
<td>76,000</td>
<td>100</td>
<td>7,600,000</td>
</tr>
<tr>
<td>Minor upgrades at existing park-and-ride lots</td>
<td>100,000</td>
<td>10</td>
<td>1,000,000</td>
</tr>
</tbody>
</table>

### Service Recommendations

- **Major improvements in walk and bike facilities**: 350,000
- **Other improvements to extend paratransit service**: 250,000

### Subtotal New Capital Improvements

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major improvements in walking and biking facilities</td>
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<td></td>
</tr>
<tr>
<td>Other improvements to extend paratransit service</td>
<td>250,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,040,000</td>
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</tr>
</tbody>
</table>

### Additional Capital Items to Support Service Recommendations

- **Major improvements in walking and bike facilities**: 350,000
- **Other improvements to extend paratransit service**: 250,000

### Total - Alt Y Improvements

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major improvements in walking and biking facilities</td>
<td>790,000</td>
<td></td>
</tr>
<tr>
<td>Other improvements to extend paratransit service</td>
<td>250,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,040,000</td>
<td></td>
</tr>
</tbody>
</table>

### Total Alt Y Improvements

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major improvements in walking and biking facilities</td>
<td>790,000</td>
<td></td>
</tr>
<tr>
<td>Other improvements to extend paratransit service</td>
<td>250,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,040,000</td>
<td></td>
</tr>
</tbody>
</table>
### Alternative Two - Enhanced Transit Operations to better Service Choice (Service and Facility Recommendations are in **Bold** to those identified in Alternative 1)

#### Capital Requirements

<table>
<thead>
<tr>
<th>Route/Corridor</th>
<th>Service Changes</th>
<th>Availability</th>
<th>Unit Costs (including factor for spare relations)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oro Valley/U of Arizona</td>
<td>Direct park-only express service between Oro Valley (101 and 191) to U of Arizona</td>
<td>11</td>
<td>New park-only lot in vicinity of 191/Oracle</td>
<td></td>
</tr>
<tr>
<td>Maricopa Int. Area</td>
<td>Direct park-only express service between I-10 and SR 99 in vicinity of Corrales Farms</td>
<td>13</td>
<td>New park-only lot in vicinity of 191/Oracle</td>
<td></td>
</tr>
<tr>
<td>North/South Corridor between Oro Valley, Downtown Tucson, U of A and Tubac</td>
<td>Continues park-only express service between Oro Valley (101 Avenue and SR 380) to Downtown Tucson and Tubac Trolley</td>
<td>12</td>
<td>New park-only lot in vicinity of 191/Oracle</td>
<td></td>
</tr>
<tr>
<td>Tucson Freeway and central Tucson and TkA Industrial area</td>
<td>Continues express service from park-and-ride lot in NE area (existing lot at Speedway/Harrison or new lot in vicinity of Tanque Verde/Broadway/Rt 103) distribution service from TkA to central industrial area</td>
<td>11</td>
<td>Continues express service from park-and-ride lot in NE area (existing lot at Speedway/Harrison or new lot in vicinity of Tanque Verde)</td>
<td></td>
</tr>
<tr>
<td>Green Valley South to U of A TkA Industrial area and Downtown Tucson</td>
<td>Direct park-only express service to U of A TkA Industrial area and Downtown Tucson</td>
<td>11</td>
<td>Initiates in green valley industrial area near I-10 expansion to new lot in vicinity of Tanque Verde/Broadway</td>
<td></td>
</tr>
<tr>
<td>Tucson Freeway</td>
<td>None</td>
<td>11</td>
<td>Initiates in Green Valley Industrial area; service operates limited service in peak periods</td>
<td></td>
</tr>
<tr>
<td>Harjoou/Howellway to Downtown Tucson</td>
<td>None</td>
<td>11</td>
<td>Initiates to park-and-ride lot in SE area of Harjoou</td>
<td></td>
</tr>
<tr>
<td>Mallory service to SE Industrial Area</td>
<td>None</td>
<td>11</td>
<td>New network of shuttle buses operating from vicinity of Harjo to various locations in the SE Industrial, will be connected with express bus service</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal New Express Service</strong></td>
<td></td>
<td></td>
<td>60,725 $</td>
<td>6,571,675 $</td>
</tr>
<tr>
<td>Speedway</td>
<td>Local service only - all stops are served</td>
<td>5</td>
<td>Signal preemption</td>
<td>6,375 $</td>
</tr>
<tr>
<td>Broadway</td>
<td>Route 8 - Broadway express service</td>
<td>6</td>
<td>Signal preemption</td>
<td>6,375 $</td>
</tr>
<tr>
<td>South Street/Wilmot</td>
<td>Route 1 - Wilmot/Broadway</td>
<td>5</td>
<td>Signal preemption</td>
<td>6,375 $</td>
</tr>
<tr>
<td>McKellips Rd to R and Comballis Parkway</td>
<td>Local service only - all stops are served, service operates between Transport Mill and U of A</td>
<td>13</td>
<td>Signal preemption</td>
<td>12,750 $</td>
</tr>
<tr>
<td>6th Avenue</td>
<td>Local service only - all stops are served</td>
<td>5</td>
<td>Signal preemption</td>
<td>6,375 $</td>
</tr>
<tr>
<td>Houghton</td>
<td>None</td>
<td>6</td>
<td>Signal preemption</td>
<td>6,375 $</td>
</tr>
<tr>
<td><strong>Subtotal New Limited/Stop Overlay Service</strong></td>
<td></td>
<td></td>
<td>80,275 $</td>
<td>8,675,125 $</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>140,975 $</td>
<td>15,250,800 $</td>
</tr>
</tbody>
</table>

#### Operating and Capital Costs

<table>
<thead>
<tr>
<th>Route/Corridor</th>
<th>Service Changes</th>
<th>Availability</th>
<th>Unit Costs (including factor for spare relations)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rio Nuevo/Trinity Street</td>
<td>Local service with extensions from downtown</td>
<td>17</td>
<td>New signalized bus, on-street stops, shelters, park, medians, etc.</td>
<td></td>
</tr>
</tbody>
</table>

#### Capital Unit Cost Items

| Bus Operating | 140,975 $ | 8,200,000 $ | 106 | 83,060,000 $ | 1,500,600 $ | 99,000,000 $ | 111,295,000 $ |
|----------------|-----------|-------------|-----------------|--------|
| **Total** | | | 140,975 $ | 8,200,000 $ | 106 | 83,060,000 $ | 1,500,600 $ | 99,000,000 $ | 111,295,000 $ |
## Alternative 2 Recommendations - Operating Characteristics, Required Vehicles, and Annual Hours

### New Express Service

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Distance (Roundtrip)</th>
<th>Ave. Speed</th>
<th>Travel Time including Time at each End of Route</th>
<th>Headways</th>
<th>Additional Vehicles</th>
<th>Additional Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Travel Time in minutes (Roundtrip for line-haul portion)</td>
<td>Pass. Loading time at origin and dest. Ends</td>
<td>Total Time for Route</td>
<td>No of Vehicles</td>
</tr>
<tr>
<td>OV/U of A/Downtown Tucson</td>
<td>30</td>
<td>20</td>
<td>120</td>
<td>15</td>
<td>135</td>
<td>15</td>
</tr>
<tr>
<td>Marana/SE Ind</td>
<td>50</td>
<td>20</td>
<td>150</td>
<td>15</td>
<td>165</td>
<td>15</td>
</tr>
<tr>
<td>OV/Downtown Tucson/TIA</td>
<td>40</td>
<td>20</td>
<td>120</td>
<td>30</td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>NE area to TIA</td>
<td>40</td>
<td>20</td>
<td>120</td>
<td>15</td>
<td>135</td>
<td>15</td>
</tr>
<tr>
<td>Green Valley/Sahuarita/SE Ind Area</td>
<td>40</td>
<td>20</td>
<td>120</td>
<td>15</td>
<td>135</td>
<td>15</td>
</tr>
<tr>
<td>SE Tucson/Houghton Rd./Downtown Tucson</td>
<td>40</td>
<td>20</td>
<td>120</td>
<td>15</td>
<td>135</td>
<td>15</td>
</tr>
<tr>
<td>SE Industrial Area Shuttle Network</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>0</td>
<td>30</td>
<td>5</td>
</tr>
</tbody>
</table>

**Subtotal - New Express Service**

|          | 76 | 80,325 |

### New Skip Stop Service

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Distance (Roundtrip)</th>
<th>Ave. Speed</th>
<th>Travel Time including Time at each End of Route</th>
<th>Headways</th>
<th>Additional Vehicles</th>
<th>Additional Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speedway</td>
<td>24</td>
<td>20</td>
<td>72</td>
<td>0</td>
<td>72</td>
<td>15</td>
</tr>
<tr>
<td>Broadway</td>
<td>24</td>
<td>20</td>
<td>72</td>
<td>0</td>
<td>72</td>
<td>15</td>
</tr>
<tr>
<td>Sixth Street</td>
<td>30</td>
<td>20</td>
<td>90</td>
<td>0</td>
<td>90</td>
<td>15</td>
</tr>
<tr>
<td>Campbell</td>
<td>50</td>
<td>20</td>
<td>150</td>
<td>0</td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>6th Avenue</td>
<td>20</td>
<td>20</td>
<td>60</td>
<td>0</td>
<td>60</td>
<td>15</td>
</tr>
<tr>
<td>Houghton Road</td>
<td>20</td>
<td>20</td>
<td>60</td>
<td>0</td>
<td>60</td>
<td>15</td>
</tr>
<tr>
<td>Avernon Way</td>
<td>25</td>
<td>20</td>
<td>75</td>
<td>0</td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td>Anklam/ST Mary's</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>0</td>
<td>30</td>
<td>15</td>
</tr>
</tbody>
</table>

**Subtotal - Skip Stop Service**

|          | 49 | 52,275 |

**Bus spare ratio factor** 20%

**Average hours per bus** 5

**Annualization factor** 255
Alternative 3 - Aggressive Efforts to Expand High-Capacity Transit

Estimated BRT/LRT Capital Costs - Two Major Corridors

<table>
<thead>
<tr>
<th>Potential BRT/LRT Corridors</th>
<th>Approximate Length (miles)</th>
<th>Capital Cost Estimates - (in millions)*</th>
<th>Potential Daily Ridership (total boardings)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bus Rapid Transit</td>
<td>Light Rail Transit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost/Mile</td>
<td>Cost/Mile</td>
</tr>
<tr>
<td>Broadway (Houghton/Downtown Tucson)</td>
<td>13</td>
<td>$ 9,000,000 $ 117,000,000</td>
<td>$ 34,790,000 $ 452,270,000</td>
</tr>
<tr>
<td>Oracle Road/Downtown Tucson/South Tucson</td>
<td>22</td>
<td>$ 9,000,000 $ 198,000,000</td>
<td>$ 34,790,000 $ 765,380,000</td>
</tr>
</tbody>
</table>

* - Report on Bus Rapid Transit, General Accounting Office (for BRT, the unit cost for Bus on HOV Lanes identified by the GAO report was used)

New Direct Access Ramps at Major Park-and-Ride Locations

<table>
<thead>
<tr>
<th>No of Locations</th>
<th>Unit Cost**</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>$ 18,430,000</td>
<td>$ 110,580,000</td>
</tr>
</tbody>
</table>

** - Per cost estimates for new direct access ramp in Snohomish County, WA
### Potential BRT Service Characteristics

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Service Periods</th>
<th>Distance (Roundtrip)</th>
<th>Ave. Speed</th>
<th>Travel Time</th>
<th>Headways</th>
<th>Additional Vehicles</th>
<th>Additional Hours</th>
<th>Annual Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No of Vehicles</td>
<td>Hrs/Veh Total</td>
<td>Rate*</td>
</tr>
<tr>
<td>Peak/Midday</td>
<td>26 20 78 10</td>
<td>8 10</td>
<td>12 96</td>
<td>24,480</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday evenings</td>
<td>26 20 78 15</td>
<td>6 7</td>
<td>6 38</td>
<td>9,180</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td>26 20 78 15</td>
<td>6 7</td>
<td>14 84</td>
<td>4,368</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunday</td>
<td>26 20 78 15</td>
<td>6 7</td>
<td>12 72</td>
<td>3,744</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total/</td>
<td>26 31</td>
<td>41,772</td>
<td>12 100</td>
<td>$4,177,200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Potential LRT Service Characteristics

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Service Periods</th>
<th>Distance (Roundtrip)</th>
<th>Ave. Speed</th>
<th>Travel Time</th>
<th>Headways</th>
<th>Additional Trains</th>
<th>Additional Hours</th>
<th>Annual Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No of Trains</td>
<td>Hrs/Veh Total</td>
<td>Rate (low)</td>
</tr>
<tr>
<td>Peak/Midday</td>
<td>26 30 52 10</td>
<td>6 7</td>
<td>12 72</td>
<td>18,360</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday evenings</td>
<td>26 30 52 15</td>
<td>4 5</td>
<td>6 24</td>
<td>6,120</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td>26 30 52 15</td>
<td>4 5</td>
<td>14 56</td>
<td>2,912</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunday</td>
<td>26 30 52 15</td>
<td>4 5</td>
<td>12 48</td>
<td>2,496</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total/</td>
<td>18 22</td>
<td>29,888</td>
<td>200 $</td>
<td>5,977,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

* - Per GAO Report on BRT
Spare ratio factor 20%
Annualization factors
Peak/midday/weekday evening 255
Sat/Sun 52

---

Costs for BRT: Broadway/Speedway/Sixth Street + Oracle Road/South Sixth Ave.

Costs for LRT: Broadway/Speedway/Sixth Street + Oracle Road/South Sixth Ave.

100 $ 4,177,200
100 $ 6,877,800
100 $ 8,920,080
100 $ 5,977,000
100 $ 5,361,078
100 $ 8,966,400
100 $ 7,718,753
100 $ 17,079,839