CROSS-COUNTY MetroLink Extension

Segment 1
Conceptual Design

Cross-County
MetroLink
Extension

Preliminary Operations Plan
Final Technical Report

Prepared for the
East-West Gateway Coordinating Council
in association with the
Bi-State Development Agency
Missouri Department of Transportation

By Parsons Transportation Group
and Associated Consultants

August 1999

Cross-County MetroLink Extension
Segment 1
Conceptual Design

Preliminary Operations Plan
Final Technical Report

Prepared for the
East-West Gateway Coordinating Council
in association with the
Bi-State Development Agency
Missouri Department of Transportation

By Parsons Transportation Group
and Associated Consultants

Chicago, Illinois
Draft March 1999
Final August 1999
Revised September 1999

Contents

1.	INTRODUCTION	1
2.	OPERATING PARAMETERS	2
	Operating Speeds	2
	Load Factors, Service Hours and Fare Policy	3
	Traffic Level of Service Standards	3
3.	RAIL OPERATIONS	6
	Route/Stops/Run Times	6
	Headways/Vehicle Requirements	7
	System Control & Communications	8
	Track Configuration	10
	Storage/Repair Facilities	11
	Emergency Operations/Weather Considerations/Recovery Operations	11
4.	BUS OPERATIONS	13
	Bus Service Strategy	13
	Bus Service Plan	17
	Stops and Stations	25
	Need for Preferential Facilities	27

5. TRAFFIC MANAGEMENT 28
MetroLink Station Access 28
At-Grade Operations 33
Basic Considerations 34

LIST OF FIGURES

Figure 1 - Shrewsbury Yard Site Plan 12
Figure 2 - Proposed Bus Service Plan 18
Figure 3 - Community Feeder Bus Service 19
Figure 4 - LRT Signal Aspects 50
Figure 5 - Proposed Traffic Sequencing 55

LIST OF TABLES

Table 1 - Definition of Levels of Service 5
Table 2 - Bus Service Modifications 20
Table 3 - Operations Plan - Feeder Bus Service 21
Table 4 - Existing Peak Hour Traffic Volumes 36
Table 5 - Traffic Capacity Analysis - A.M. Peak Hours 60
Table 6 - Traffic Capacity Analysis - P.M. Peak Hours 61

NEXT
PREVIOUS
BACK TO TOC

1
Introduction

The purpose of this report is to present a preliminary operations plan for the Cross-County MetroLink Extension Segment I. These operations apply to the candidate alternatives[1] identified for conceptual design.

The operations plan addresses two primary topics: (1) the transit services to be provided along the new MetroLink line as well as other services supporting this transit line, including modifications and additions to the Bi-State Development Agency (BSDA) bus route; and (2) traffic management associated with the at-grade alternatives and station access.

NEXT
PREVIOUS
BACK TO TOC

[1] Candidate Alternatives as adopted by the East-West Gateway Coordinating Council, 10/28/98.

2
Operating Parameters

As a framework for the operating plan, a series of operating parameters have been identified. These represent certain key policies, standards, and assumptions concerning the performance of this proposed MetroLink extension.

Operating Speeds

The operations goal for MetroLink is to provide attractive, reliable and efficient service. These qualities would have benefits for both the customer and the operating agency. A key attribute in this regard is operating speed. For the customer, travel times would be low (i.e., speeds high). For the agency, safe high speeds would achieve efficiency (number of trips per hour per vehicle) for the service.

The MetroLink system is designed to operate at speeds up to 55 miles per hour. Achievement of such speed will be controlled by track alignment, gradients, stops, and operating environment. Specifically:

1. The train line will operate within two different environments:
   a. grade-separated
   b. shared public right-of-way

2. Under grade-separated conditions, the operating speed will be controlled by normal operating rules established by BSDA. Speeds will conform to safe operating levels consistent with the horizontal and vertical curvature of the alignment. Within these constraints, speeds up to 55 mph are possible. Approaches to and departures from stations will be governed by maximum deceleration and acceleration rates of 3 mph/sec.

3. Under shared public right-of-way conditions, the tracks will be operated as a reserved space for MetroLink trains only, i.e., no longitudinal or mixed travel by other traffic along the tracks.

However, traffic will be permitted to crossover the tracks at various dedicated locations such as intersections, land-use access drives, and parking access.

Within this environment, train speeds will be governed by the speed limit established for the given road in which tracks are located and by the operation of the traffic signal system. The latter will be operated in a fashion to either provide signal priority or pre-emption.

Train speeds in this operating environment will not exceed 45 mph. Again, speed will be further constrained by track alignment and station stops.

Load Factors, Service Hours and Fare Policy

Other key characteristics of the operating framework include load factors, service hours, and fare policy.

1. Load Factors
   For MetroLink, the load factor will be 125% of seated capacity (AW2 - 72 seated, 90 standing). For bus service, express bus routes would have a 100% load factor while local routes would have a 125% of seated capacity factor.

2. Service Hours
   The service hours will be the same as currently provided by MetroLink, i.e., from 5:00 A.M. to 12:40 A.M. Local bus service would operate for 21 hours from 4:30 A.M. to 1:30 A.M.; express buses would operate for a six hour period 6:00 A.M. to 9:00 A.M. and 3:00 P.M. to 6:00 P.M.

3. Fare Policy
   BSDA plans to engage a consultant to examine their current fare policy and determine a fare policy for future operations.

Traffic Level of Service Standards

Because of the potential design concepts that include shared use of public right-of-way, the quality of traffic flow on the street system in the vicinity of MetroLink tracks is an important consideration. The relationship to traffic flows occurs in two types of situations:

1. Coordinated traffic flow in which MetroLink trains operate along public streets, in reserved right-of-way, and through intersections of arterial streets.

2. Bus, park-n-ride, kiss-n-ride access to MetroLink Stations involves new traffic generation and new or changed use of the street system.

For both situations, the traffic level of service standard would be LOS D, as defined by the Highway Capacity Manual (See Table 1).

TABLE 1

Level of service for signalized intersections is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. Specifically, level-of-service (LOS) criteria are stated in terms of the average stopped delay per vehicle for a 15-minute analysis period. The criteria are given in Table listed below. Delay may be measured in the field or estimated using procedure presented later in this chapter. Delay is a complex measure and is dependent upon a number of variables, including the quality of progression, the cycle length, the green ratio, and the *v/c* ratio for the lane group in question.

LOS A describes operations with very low delay, up to 5 sec per vehicle. This level of service occurs when progression is extremely favorable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

LOS B describes operations with delay greater than 5 and up to 15 seconds per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS

LEVEL OF SERVICE	STOPPED DELAY PER VEHICLE (SEC)
A	≤5.0
B	>5.0 AND ≤ 15.0
C	>15.0 AND ≤ 25.0
D	>25.0 AND ≤ 40.0
E	>40.0 AND ≤ 60.0
F	>6.0.0

LOS C describes operations with delay greater than 15 and up to 25 seconds per vehicle. These higher delays may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LOS D describes operations with delay greater than 25 and up to 40 seconds per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high *v/c* ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LOS E describes operations with delay greater than 40 and up to 60 seconds per vehicle. This level is considered by many agencies to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high *v/c* ratios. Individual cycle failures are frequent occurrences.

LOS F describes operations with delay in excess of 60 seconds per vehicle. This level, considered to be unacceptable to most drivers, often occurs with over saturation, that is, when arrival flow rates exceed the capacity of the intersection. It may also occur at high *v/c* ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Source: Highway Capacity Manual, Transportation Research Board, 1994

3
Rail Operations

The Cross-County MetroLink Extension Segment I will fall under the authority of BSDA for operations, maintenance and service. The current operating rules and policies used for Bi-state's Airport Main/East St. Louis segment and the new St. Clair County Extension (under construction) will be implemented for operation of the Cross-County Segment I Extension. The entire MetroLink system will be managed and operated under one set of parameters (rules). Each newly constructed MetroLink segment (St. Clair County, Cross-County Segment I Extension) will blend into the original Airport Main/East St. Louis segment to form one homogeneous, seamless system.

Route/Stops/Run Times

For purposes of preparing this preliminary operating plan, primary Cross-County operations will be expanded to be between the Shrewsbury station at Lansdowne Avenue just south of I-44 and the Emerson Park (IL) station on the St. Clair Extension. Intermediate station stops are planned for the following Cross-County Corridor locations; Deer Creek, Manchester Road, Eager Road, Galleria, Clayton CBD near Carondelet and Meramec, East Clayton near the Ritz Carlton, Big Bend Boulevard, Skinker Boulevard (Washington University), and Forest Park. Cross-County service schedule would begin at approximately 5:15 a.m. and continue until just past midnight. There is a possibility the Cross-County service could initiate operations as a shuttle between the Forest Park and Shrewsbury stations.

Headways/Vehicle Requirements

Currently MetroLink operates a two track, directional movement system at 7.5 minute, 10 minute, and 15 minute headways throughout the day between Airport Main station and the Fifth and Missouri station in East St. Louis, Illinois. As previously mentioned, the Cross-County Segment I Extension would run to Emerson Park in order to facilitate a turn-back movement that may be interwoven into the existing MetroLink operation. One possible Cross-County service scenario would be as follows;

MONDAY THROUGH FRIDAY

Depart Shrewsbury Station Eastbound		***Depart Emerson Park (IL) Westbound***	
5:00 a.m. - 6:00 a.m.	every 15 minutes	5:15 a.m. - 6:15 a.m.	every 15 minutes
6:00 a.m. - 9:30 a.m.	every 8 minutes	6:15 a.m. - 9:30 a.m.	every 8 minutes
9:30 a.m. - 4:15 p.m.	every 12 minutes	9:30 a.m. - 3:30 p.m.	every 12 minutes
4:15 p.m. - 6:30 p.m.	every 8 minutes	3:30 p.m. - 6:45 p.m.	every 8 minutes
6:30 p.m. - Midnight	every 15 minutes	6:45 p.m. - 12:40 a.m.	every 15 minutes

SATURDAY

Depart Shrewsbury Station Eastbound		***Depart Emerson Park (IL) Westbound***	
5:00 a.m. - 7:30 a.m.	every 30 minutes	6:00 a.m. - 8:00 a.m.	every 30 minutes
7:30 a.m. - 10:45 a.m.	every 15 minutes	8:00 a.m. - 10:30 a.m.	every 15 minutes
10:45 a.m. - 8:00 p.m.	every 12 minutes	10:30 a.m. - 7:00 p.m.	every 12 minutes
8:00 p.m. - 11:00 p.m.	every 15 minutes	7:00 p.m. - Midnight	every 15 minutes
11:00 p.m. - Midnight	every 30 minutes		

SUNDAY

Depart Shrewsbury Station Eastbound		***Depart Emerson Park (IL) Westbound***	
5:30 a.m. - 7:30 a.m.	every 30 minutes	6:00 a.m. - 8:30 a.m.	every 30 minutes
7:30 a.m. - 11:00 a.m.	every 15 minutes	8:30 a.m. - 10:30 a.m.	every 15 minutes
11:00 a.m. - 7:00 p.m.	every 12 minutes	10:30 a.m. - 7:00 p.m.	every 12 minutes
7:00 p.m. - 10:00 p.m.	every 15 minutes	7:00 p.m. - 10:30 p.m.	every 15 minutes
10:00 p.m. - 11:00 p.m.	every 30 minutes	10:30 p.m. - 11:30 p.m.	every 30 minutes

The service headways for the various operating periods are a derivative of the output from the ridership forecast demand models and the BSDA minimum service level policies. Another consideration will be the infusion of the St. Clair County trains into the existing MetroLink traffic mix

between Downtown St. Louis and the airport. The St. Clair County trains will further reduce track capacity and headways to 3 minutes and 45 seconds during rush hours. Careful planning and operation will be required to blend the Cross-County trains into the system and maintain a minimum headway of ninety seconds. Modifications to the signal system will be required to accommodate ninety second headways.

Station stops factor into the total trip time for the segment also. All station platforms have been designed for two car consists. Many of these could be enlarged, but at some of the Downtown St. Louis stations MetroLink service is limited to two car consists because of station platform restrictions. Maximum passenger capacity could easily be reached on some heavily traveled line segments (especially during rush hour service) making some form of skip-stop service a practical and efficient operation to enhance capacity.

The vehicle requirements to meet the projected Cross-County Segment I level of service are a function of total round-trip route travel time plus the desired level of service (headway)[2]. Assuming the travel time is consistent for all trains it will take approximately two hours for one equipment consist (two cars) to circulate the Cross-County corridor route from Shrewsbury to Emerson Park and back to Shrewsbury. This also assumes a ten minute layover period at the service end points, Emerson Park and Shrewsbury. The following table compares the vehicle requirements with various service headways;

Service Headway	Vehicle Requirements[3]
6 minutes	40 cars (46 with spares)
8 minutes	30 cars (34 with spares)
10 minutes	24 cars (28 with spares)
12 minutes	20 cars (23 with spares)
15 minutes	16 cars (18 with spares)

In addition to the basic vehicle requirements to meet the desired level of service, spare cars (15% of the basic fleet) will be required to cover breakdowns, routine maintenance, and other equipment servicing requirements.

System Control and Communications

All MetroLink operations are controlled from a central Control Center that is located within the Ewing Shop facility. LRT operations are monitored through the use of the following equipment and communication links;

- Train Monitoring - The SCADA train control system provides the location of trains via computer monitoring. The actual train movements are governed by a wayside block signaled and cab control system.

[2]Headways and route travel times are subject to further analysis.
[3]Fleet requirements may be adjusted pending ridership forecast estimates.

- Regulation and supervision of the train operations and supervisory control of the associated electrical, mechanical and communications subsystems is performed by staff located at the Control Center. The Control Center functions as the nerve center of the LRT operations. All aspects of mainline and station maintenance activities that affect train operation are controlled, directed and monitored from the Control Center.

- The LRT system's response to service disruptions shall include modifications of schedules and routes. In all cases, Control Center personnel have the capacity of overriding or modifying any automatically initiated failure management strategy.

- Radio Communication - A two-way radio system is in place which allows the Control Center to communicate with all trains on the mainline and in the yard and with on-street supervisory personnel. Trains on the mainline are capable of monitoring transmissions from the Control Center.

- Telephones - Telephones at the Control Center provide access to the administrative telephone lines, maintenance phones and direct-line communications with passengers using passenger assistance phones. Passenger Assistance Telephones (PAT's) are located at all stations. Direct telephone access to emergency services, police, fire, and ambulance is available from the Control Center.

- Public Address - PA system equipment enables the Control Center to broadcast announcements to all stations or to selected station(s). The train operator can relay the information to passengers on-board trains.

- Video Monitoring - Monitors in the Control Center provide the Control Center Manager with sequential surveillance of activities at each station platform area.

- Tape Recording - Recording equipment is provided at the Control Center to document all radio and telephone conversations as well as video surveillance. Recording is done for individual telephone line, each radio channel, and each console.

- SCADA - The SCADA System will be used to control and monitor the power distribution equipment, as well as the signal system. In addition, all system alarms will be annunciated at the Central Control facility, including any smoke/fire detection alarms, intrusion detection alarms, equipment status alarms, and TVM status alarms. Computer terminals and printers, installed at Central Control, allow information to be entered and extracted into automated management information systems. The computer terminal will also be used to prepare a daily log of activities in preparation for management review the following day.

An emergency back-up generator ensures that uninterrupted power is available for selected Control Center activities.

Track Configuration

The entire length of the Cross-County Segment I Extension will be double-tracked. Trains will operate in the forward direction on the right hand track, except at terminal ends or during single track emergency situations. Maximum benefits are realized from LRT systems that are double-tracked. This configuration enables freedom in the selection of headways, scheduling and ridership fluctuations. Double-tracking also eliminates the difficulty of meet synchronization and inhibited schedule recovery that is associated with single track operations. A double-tracked system provides the best capability to maintain a consistently dependable level of service in the safest of operating environments.

The stations will use a center platform concept whenever possible. This allows boarding the trains from one common area. Exceptions would include some at-grade MetroLink alignments where side would be preferable. Crossovers will be located between the tracks at approximately every five minutes of travel time. This criteria would place a set of crossovers just west of the station location at Big Bend Boulevard, one near the Clayton CBD, one just south of the Galleria area, one prior to Manchester Road and a set at the terminus just north of Lansdowne.

The existing track layout at the Forest Park station will be reconfigured to accommodate the connection to the Cross-County Segment I Extension. This reconfiguration will provide for additional platforms that will be served by all trains passing through the Forest Park station. There is also a provision in the reconfiguration plan for a pocket track in which trains may be held to accommodate headway requirements or turned back to return westward toward Clayton without continuing eastward toward St. Louis.

As discussed later in chapter 5, there will be no shared space with other traffic along the MetroLink tracks. Physical barriers and other design features will be employed to minimize other vehicular traffic from crossing over MetroLink track except at designated grade crossings.

Storage/Repair Facilities

The addition of approximately 18 to 46 more cars for the Cross-County Segment I Extension will overburden the existing Bi-State Ewing shop facility in St. Louis as well as the planned facility in East St. Louis, Illinois for the St. Clair Extension. Provisions must be provided for the additional Cross-County fleet as well as for future equipment at a logistically beneficial site. For initial service scenarios, a storage yard with facilities to perform basic car cleaning, routine inspections, minor repairs, and train washing is required. For an interim period, heavy repairs could be performed at either the Ewing or East St. Louis shops. Minor repairs, scheduled inspection work, component replacement, lubrication and testing require a relatively short time and do not necessitate the use of special machinery. A preliminary conceptual layout for this type of minimum service facility is shown on the schematic plan (Figure 1) on the following page.

The footprint for a yard storage, routine service, and minor repair facility must provide space for the storage tracks, spare parts and materials storage, office accommodations, inspection pit, train washer, and employee parking. A simple enclosed shop building to service the equipment is desirable. The yard storage tracks can be spaced apart to allow for paved platforms to be placed between the tracks for access to service the vehicles. Open inspection pits can be constructed under these yard tracks or under a designated inspection track. Temporary trailers may be used to provide office space until such time as a shop facility is constructed.

The BSDA preference is to expand the Ewing Shop Facility to cover the maintenance and repair of Cross-County vehicles. This alternative would achieve several efficiencies in use of labor and storage of parts and supplies. Obtaining sufficient property on which to expand the Ewing Shop Facility is the key issue that must be addressed by BSDA. With the expansion of the Ewing Shop to handle the maintenance and repair of the Cross-County equipment a minimum service facility to provide car cleaning, staging, and storage will still be needed at the Deer Creek/Lansdowne area.

Emergency Operations/Weather Considerations/Recovery Operations

Abnormal and emergency operations are required when a problem precludes operation according to normal procedures or prevents service according to the operating timetable. Problems may arise from equipment malfunction on the train, track or power system. Accidents or incidents, track blockage, passenger illness, or weather may also cause problems.

Since the Cross-County operations will become part of the BSDA MetroLink System the existing BSDA policies will govern any emergency operations, weather considerations and recovery operations. The existing policies may be modified as required for Cross-County operations.

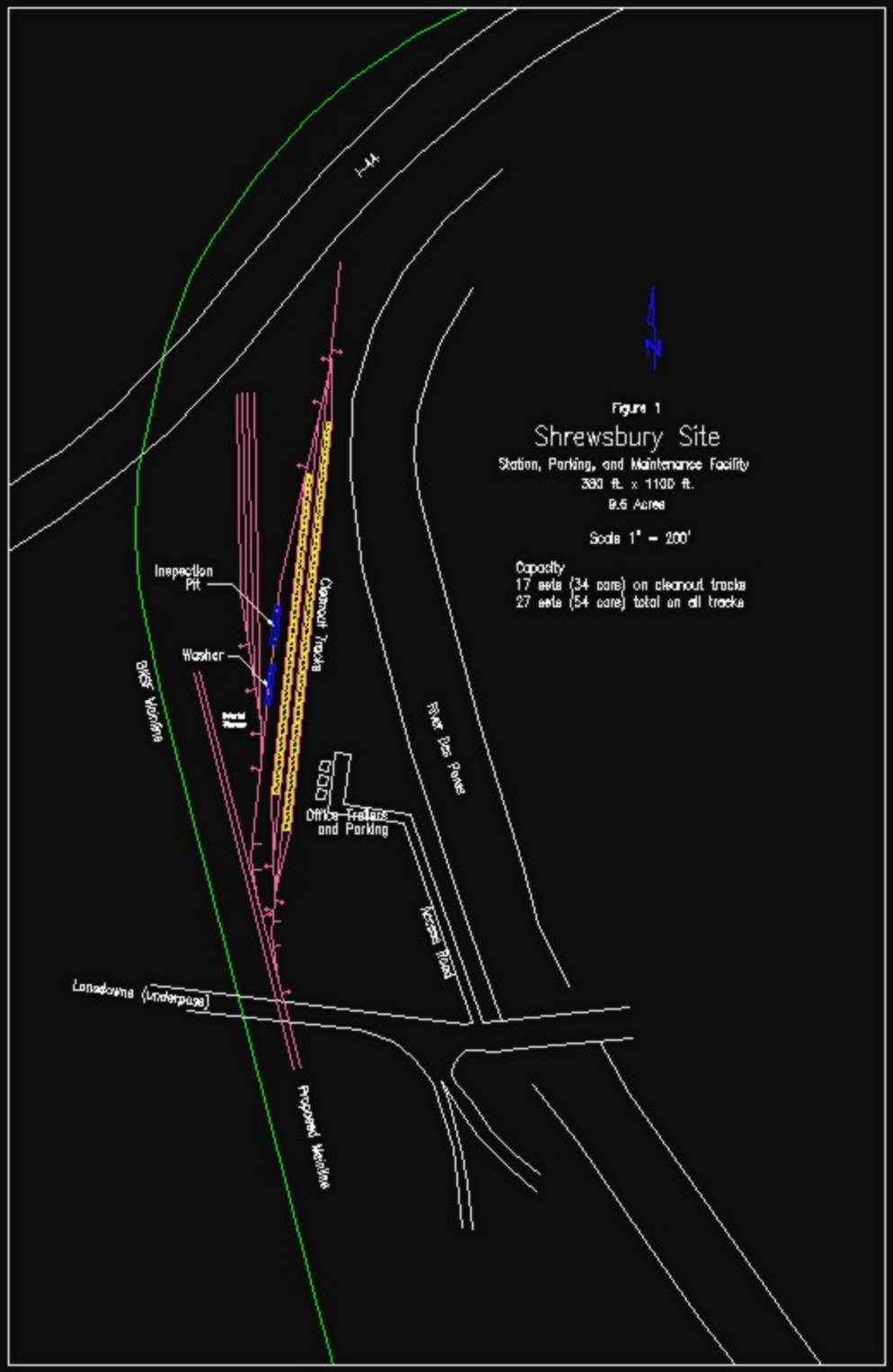


Figure 1

Shrewsbury Site

Station, Parking, and Maintenance Facility
380 ft. x 1100 ft.
9.5 Acres

Scale 1" = 200'

Capacity
17 sets (34 cars) on cleanout tracks
27 sets (54 cars) total on all tracks

4
Bus Operations

The bus service plan is aimed at providing necessary support for MetroLink via improvements to the bus route/service system that link to proposed stations. These improvements provide a means to extend and enhance transit accessibility in the Cross-County corridor and beyond. The service plan also seeks to achieve improved efficiency by modify existing BSDA routes where they would provide redundant service to the new MetroLink line thereby saving resources that could be reinvested in other parts of the corridor.

Bus Service Strategy

Based upon a review of the existing BSDA bus route system in relation to the potential MetroLink stations in the Cross-County corridor, a bus service strategy, including a series of improvements and modifications, is recommended.

The purpose of this strategy is to leverage the newly available and high quality transit service, represented by the Cross-County MetroLink extension to Shrewsbury, into an enlarged role for transit in the corridor and into the south/southwest sections of the St. Louis region. An enhanced role would be measured in terms of increased transit ridership and, potentially, an increased share of the total travel market.

The means to leverage MetroLink would be accomplished via significant improvements to BSDA bus services. Quality and capacity on MetroLink would be balanced by equivalent quality and capacity in connecting bus services.

The recommended strategy would include four types of bus improvements:

1. Various existing bus routes would have modest locational adjustments to effectively connect to proposed MetroLink stations.

2. Various existing bus routes within the central and easterly portion of the corridor would be shortened or eliminated as being redundant to MetroLink (this will save resources for reinvestment in other parts of the corridor).

3. Provide new service within the corridor to extend the accessibility of MetroLink to major activity centers, business concentrations, and/or major institutions.

4. Provide new service to extend and expand MetroLink accessibility into the south and southwest suburban areas.

The geographic focal points for this four-part strategy would be:

1. existing bus routes in the vicinity of the ten potential new MetroLink stations in the Cross-County corridor from the Forest Park station (at DeBaliviere Avenue) to Shrewsbury (at Lansdowne Avenue).

2. existing bus routes in the Forest Park Parkway, Millbrook Boulevard, and downtown Clayton sections of the corridor, i.e., these sections have routes generally paralleling the proposed MetroLink line.

3. major activity centers and areas that will be beyond reasonable walking distance (1/4 mile) from proposed MetroLink stations, i.e., the Galleria/Brentwood Boulevard corridor, the University City Loop area along Delmar Boulevard, St. Mary's Hospital complex, and the Forest Park area[4].

4. south and southwest suburban area roughly defined by I-44/Big Bend Boulevard on the north, I-270 on the west and south, and River Des Peres and I-55 on the east.

Of the above localities, item #4 bears special discussion. The residential area, as described, includes 12 suburban communities with a large number of neighborhoods. This area would be a significant target for increasing transit's role in serving total transportation demand. It is a stable area in terms of population and employment. Transit service is widely available, but sizeable portions of the area are not within convenient walking distance of existing bus routes. MetroLink's highly successful reputation in the St. Louis region would stimulate people to use transit. Coupled with increasing traffic congestion on major roads in the Cross-County corridor, the opportunity exists for significant gains in transit usage with corresponding benefits to the traveling public.

[4] This is a special service area to be served by an enhanced Circulator transit system.

In order to identify the most optimal means to enhance and expand transit service in the area, the existing bus service coverage has been examined. Travel time contours have also been considered in developing service concepts that could be appealing to travelers. The following summarizes the key considerations that lead to recommendations for bus service improvements:

1. The MetroLink connecting point would be the proposed Lansdowne Avenue station (or as an alternate terminus, the Deer Creek station).

2. The travel distance from I-270 to MetroLink would be in the 5-7 mile range. For a bus operating at an overall speed of 15 mph, the trip time for origins within this area to the MetroLink station could be in the 20-30 minute range. This means that total travel time to downtown Clayton could be in the 30 to 45 minute range.

3. Existing bus routes are located on several key arterial streets
   a. North-South
      - Laclede Station/Hanley Road
      - Elm Avenue
      - Tesson Ferry Road
      - Union Road
   b. East-West
      - Adams/Lockwood/Murdoch/Lansdowne Avenue
      - Watson Road/Chippewa Street
      - Gravois Road

4. Substantial portions (more than 50%) of several communities are not within 1/4 mile walking distance of bus service: Shrewsbury, Webster Groves, Crestwood, Grantwood Village, Marlborough, Oakland, Sunset Hills, Green Park, Affton, and various unincorporated areas of St. Louis County.

5. Residential areas have lower density in the outward sections.

6. Travel demand patterns would have major home-to-work demands from the suburban area inward towards Clayton and St. Louis. However, there is increased employment in suburban St. Louis County which creates a reverse commute travel pattern. Both patterns need to be recognized.

7. Significant suburban trip attraction areas would include:
   a. Watson Road commercial corridor
   b. St. Anthony's Hospital area (Tesson Ferry Road)
   c. South County shopping center (Lindbergh/Union Road)
   d. Grant's Farm (Gravois Road)
   e. Chrysler Assembly Plant (I-44)
   f. Crestwood Shopping Center.

There are several alternative transit concepts that could be deployed in this south/southwest suburban area, namely:

1. Addition of more fixed route/fixed schedule bus service that would directly link to the proposed MetroLink station; this could be accomplished via a combination of new routes penetrating currently unserved areas or new branches off of existing routes.

2. Similar to item #1 but operate service with a route deviation concept; the latter provides for a "demand-responsive" capability within new service areas that would achieve maximum customer convenience while retaining efficiency in bus operations, i.e., buses would operate through new service areas following a basic route, customers could call ahead to make a reservation for a front door pickup on a given day for which the bus would deviate from the basic route; by selecting the size of new service areas, the extent (distance or travel time) of deviation could be controlled to present a schedule.

3. Develop a feeder bus service network as an overlay on the existing fixed route/fixed schedule system; feeder buses would be organized in relation to communities (i.e., the Crestwood MetroLink bus) to create identity and simplicity for customer understanding; feeder bus would be displayed as a local bus route in currently unserved areas and would then operate in an express mode (closed door) when leaving the community for the trip to the MetroLink station; for the return trip from the station in the A.M. peak period, these buses could serve reverse commute travel by providing service along major arterial corridors to various employment locations/major activity centers in this suburban area (see previous list of potential attraction areas).

4. Similar to item #3, the community bus routes could be operated under a route deviation concept to maximize customer accessibility.

5. For the low density portion of this suburban area, reliance on the auto as the feeder mode would be significant. Areas beyond I-270 would fall into this category. The proposed Deer Creek or Lansdowne Avenue MetroLink stations would have a substantial park-n-ride/kiss-n-ride facility. It would be considered impractical to place park-n-ride/kiss-n-ride facilities at other locations with an express bus link to the MetroLink station because of the double-transfer requirement.

Given the conditions in the corridor, the bus service strategy includes a combination of options #1

and #3, the addition of new fixed route/fixed schedule routes and new community feeder routes. These represent adjustments of the existing transit system to the presence of MetroLink. Option #1 would add backbone service to the corridor along major routes with some adjustment of existing routes to focus on the proposed MetroLink station. Option #3 or #4 would penetrate new service areas as local routes, achieving a positive perception as being an entirely new service directly associated with MetroLink, without the complication of learning how to use the BSDA bus network.

Bus Service Plan

The recommended bus service plan, using the above strategy, is summarized as follows:

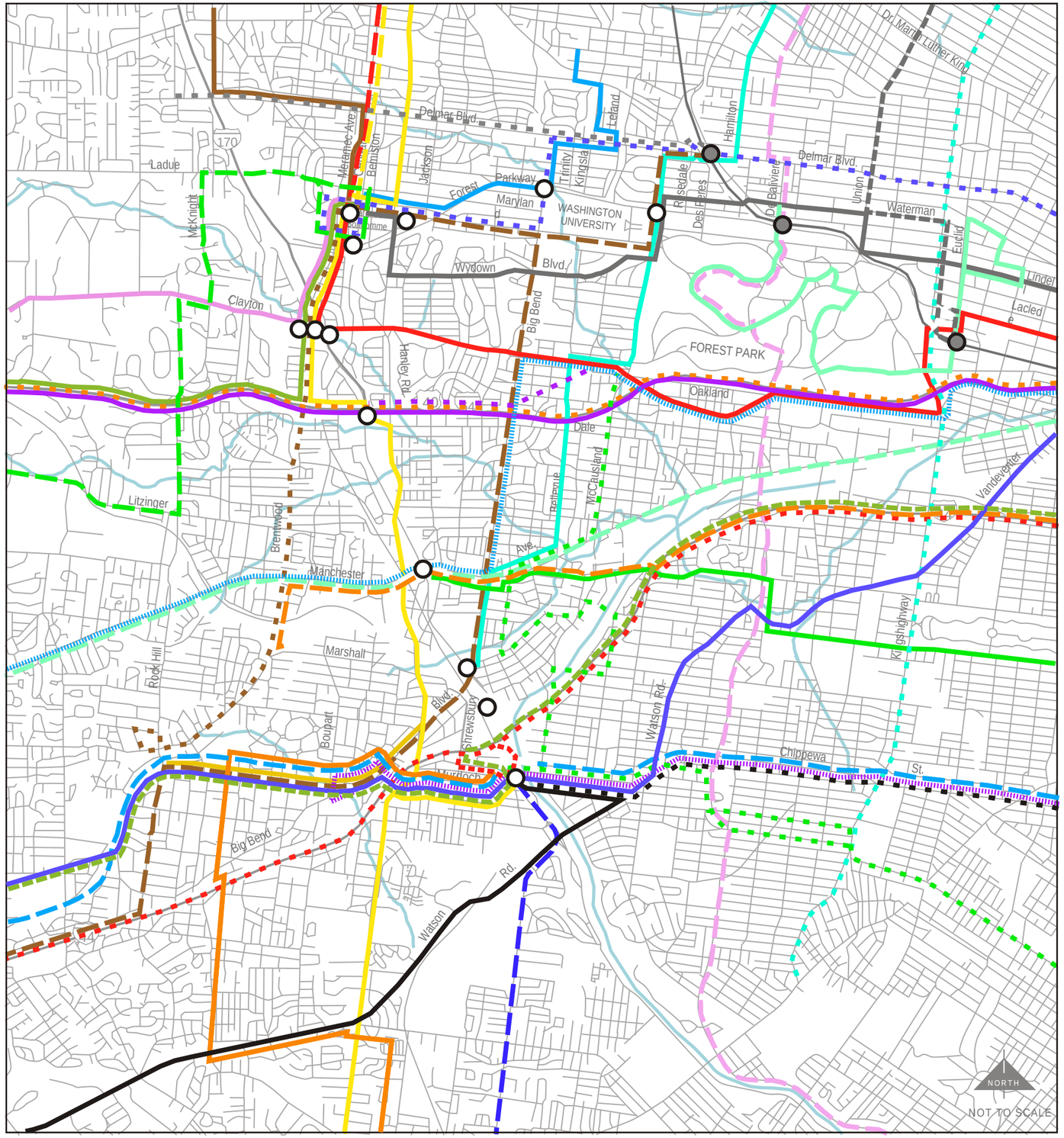
Table 2 - Describes the service improvements

Table 3 - Describes service attributes

Figure 2 - Illustrates the overall corridor network

Figure 3 - Illustrates the service plan in the south/southwest suburban area.

The recommended service in relation to the linkage to the proposed MetroLink stations is as follows:



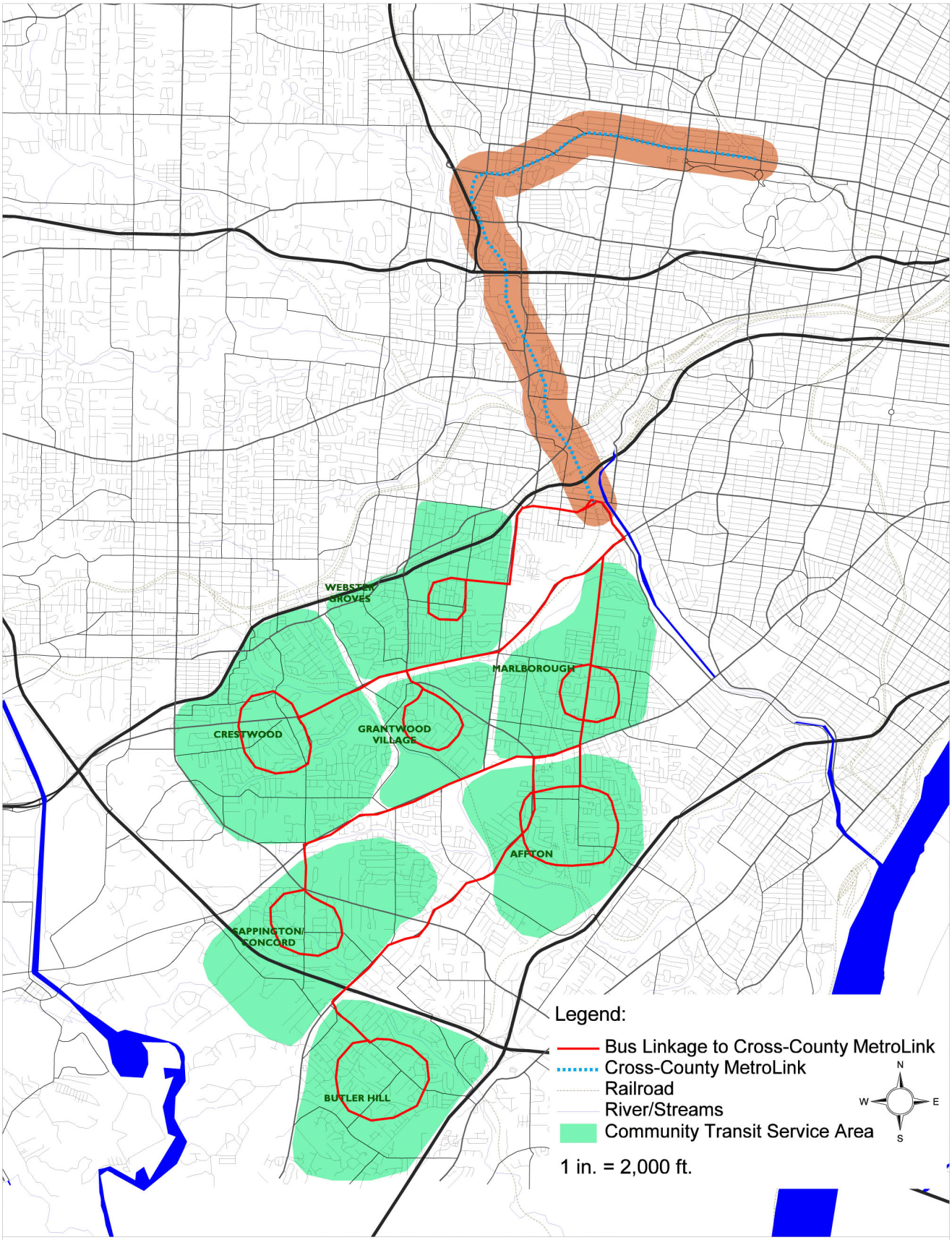
ROUTES		STATIONS	ROUTE MODIFICATION		
			EXISTING - TO REMAIN	MODIFIED	NEW
	2	Forest Park Shuttle*		X	X
	11	Chippewa		X	
	11x	Shewsbury Express		X	
	13	Union	X		
	16	City Limits		X	
	17	Clayton - Oakville	X		
	21	Tower Grove		X	
	47	Cross County		X	
	52	Forest Park		X	
	53	Litzsinger	X		
	57	Manchester	X		
	57x	Ellisville Express	X		
	58	Clayton-Ballas		X	
	63	Clayton N.W. Plaza	X		
	64	Lucas Hunt		X	
	66	Maplewood - Airport		X	
	68	Big Bend	X		
	90	Hampton	X		
	91	Olive	X		
	92	Lindenwood		X	
	93	Lindell	X		
	95	Kings Highway	X		
	97	Delmar	X		
	98	McCausland - Delnor		X	
	111x	Kirkwood Express		X	
	152x	Hwy 40 - Clayton Express	X		
	157x	Manchester Road Express	X		
	191	Chesterfield Valley Connector		X	
	357x	Twin Oaks Express		X	
	457x	Fenton Express		X	
	657	Maplewood Limited	X		
		Dale Limited (Route Deviation)**			X
		MacKenzie / Gravois			X
		Brentwood Shuttle			X
		McKnight / University City Shuttle			X
		Possible Future MetroLink Stations (including alternatives)			
		Existing MetroLink Stations			

* To be incorporated with new Forest Park Circulator

** Route shown on map only indicates the general area which will be served, not the actual route alignment

FIGURE 2
PROPOSED BUS SERVICE PLAN

Figure 3



Community Feeder Bus Service

Table 2
PRELIMINARY OPERATIONS PLAN - FEEDER BUS SERVICE
SERVICE MODIFICATIONS - FEEDER BUS SERVICE
CROSS-COUNTY LIGHT RAIL TRANSIT, ST. LOUIS, MISSOURI

NUMBER	DESCRIPTION	ACTION TAKEN
EXISTING ROUTES		
Regular Routes		
2	Forest Park Shuttle	Incorporated in Forest Park Circulator Plan
11	Chippewa	Split the route at the Lansdowne Street station; Provide different headways on the east and west branches
13	Union	None
16	City Limits	Extend this route to the south to link with either the Shrewsbury or Lansdowne station
17	Clayton-Oakville	Connect with the Lansdowne station, truncate route to the south of this station
47	Cross County	Service to remain unchanged; Route will link with various Metrolink stations along its existing alignment
52	Forest Park	Eliminate the Dale Road branch of the existing route; Otherwise alignment is unchanged
53	Litzsinger	None
55	Clayton-Galleria Shuttle Bee	Service eliminated
57	Manchester	Route split at the Manchester Road station
58	Clayton-Ballas	Truncate route east of downtown Clayton; route to utilize the future transit center in downtown Clayton
62	Kirkwood-Clayton-Wellston	Service eliminated
63	Clayton-Northwest Plaza	This route's alignment will change slightly to utilize the future transit center in downtown Clayton
64	Lucas Hunt	Maintain existing alignment and headways, connect with future transit center in downtown Clayton
66	Maplewood-Airport	Truncate to the south of downtown Clayton
68	Big Bend	Extend the existing alignment to the east to link with the existing Delmar station and to the west to link with Meramec Comm. Coll.
90	Hampton	None
91	Olive	The route will originate in downtown Clayton, rather than the Delmar station[1]
92	Lindenwood	Maintain existing alignment and connect with the Lansdowne station
93	Lindell	None
95	Kingshighway	None
97	Delmar	Connect with the Clayton, Forest Park Pkwy, Big Bend/Millbrook stations; eliminate the McKnight/Canterbury/Geoffry branch
98	McCausland-Delor	Connect with the Shrewsbury station
191	Chesterfield Valley Connector	Truncate route east of downtown Clayton
657	Maplewood Limited	None
Express Routes		
11X	Shrewsbury Express	Connect with the Lansdowne station; maintain current alignment
57X	Ellisville Express	None
111X	Kirkwood Express	Connect with Lansdowne station
152X	Highway 40-Clayton Rd. Express	None
157X	Manchester Road Express	None
357X	Twin Oaks Express	Connect with Lansdowne station[2]
457X	Fenton Express	Connect with Lansdowne station
NEW ROUTES		
Shuttle Routes		
	McKnight/Univ. City Shuttle	Provide new service
	Brentwood Shuttle	Provide new service
Regular Route		
	McKenzie-Gravois	Provide new service (Lansdowne Ave. station - McKenzie Road/Gravois Road/I-270)
Route Deviation		
	Dale Limited	Provide new service (Eager Rd. station - Bellevue/Dale)
Community Feeder Route		
	Webster Groves	Provide new feeder route (Lansdowne Ave. station - Edgar/Lockwood/Murdoch)
	Crestwood	Provide new feeder route (Lansdowne Ave. station - Sappington/Watson)
	Grantwood Village	Provide new feeder route (Lansdowne Ave. station - Rock Hill/Watson)
	Marlborough	Provide new feeder route (Lansdowne Ave. station - MacKenzie)
	Affton	Provide new feeder route (Lansdowne Ave. station - MacKenzie)
	Sappington/Concord	Provide new feeder route (Lansdowne Ave. station - Baptist Church/Gravois/MacKenzie)
	Butler Hill	Provide new feeder route (Lansdowne Ave. station - Theiss/Concord/Tesson Ferry/MacKenzie)

1. Contingent upon the improvement of the I-44 interchange at Shrewsbury Road
2. Contingent that non-stop Metrolink service is available from downtown St. Louis to downtown Clayton. If not, this route would retain its existing alignment.

Table 3
PRELIMINARY OPERATIONS PLAN - FEEDER BUS SERVICE
CROSS-COUNTY LIGHT RAIL TRANSIT, ST. LOUIS, MISSOURI

		HOURS OF OPERATION[10]			WEEKDAY HEADWAYS (MIN.)[4]			
NUMBER	DESCRIPTION	MON-FRI	SATURDAY	SUNDAY	PEAK	OFF-PEAK	NIGHT[2]	METROLINK CONNECTIONS
EXISTING ROUTES								
Regular Routes								
2	Forest Park Shuttle[15]	6:16 AM - 6:52 PM	9:46 AM - 6:52 PM	9:46 AM - 6:52 PM	15	15	----	Central West End[1], Forest Park[1]
11E	Chippewa-East	5:02 AM - 11:58 PM	5:28 AM - 10:55 PM	6:00 AM - 8:41 PM	15	20	20	Lansdowne Avenue
11W	Chippewa-West	5:47 AM - 10:43 PM	6:54 AM - 10:10 PM	7:22 AM - 9:19 PM	15	30	20	Lansdowne Avenue
13	Union	5:01 AM - 11:24 PM	6:18 AM - 9:30 PM	6:18 AM - 9:40 PM	30	30	60	Central West End[1]
16	City Limits[3]	5:07 AM - 12:10 AM	5:22 AM - 11:10 PM	6:06 AM - 10:25 PM	20	20	20	Skinker/Millbrook, Shrewsbury or Lansdowne Avenue
17	Clayton-Oakville[6]	6:18 AM - 8:18 AM; 4:10 PM - 6:21 PM	----	----	30	----	----	Lansdowne Avenue
21	Tower Grove	4:25 AM - 12:20 PM	5:20 AM - 12:50 AM	5:20 AM - 12:20 AM	25	25	45	Manchester Road
47	Cross County	5:17 AM - 11:27 PM	5:35 AM - 7:33 PM	----	15	30	80	Shrewsbury, Manchester Rd, Eager Rd, Galleria, Downtown Cla
52	Forest Park	4:33 AM - 1:07 AM	5:22 AM - 12:31 AM	5:22 AM - 12:21 AM	20	20	20	Galleria
53	Litzsinger[7]	7:36 AM - 9:44 AM; 2:28 PM - 4:12 PM	----	----	30	----	----	Downtown Clayton
57E	Manchester - East Branch	4:35 AM - 12:00 AM	5:27 AM - 10:32 PM	6:59 AM - 10:08 PM	20	20	20	Manchester Road
57W	Manchester - West Branch[11]	4:35 AM - 12:20 AM	6:46 AM - 10:19 PM	10:12 AM - 6:13 PM	30	30	30	Manchester Road
58	Clayton-Ballas	5:26 AM - 11:35 PM	6:08 AM - 8:45 AM; 1:49 PM - 10:52 PM	6:08 AM - 8:45 AM; 1:49 PM - 10:52 PM	60	60	----	Downtown Clayton
63	Clayton-Northwest Plaza	6:43 AM - 8:03 PM	----	----	45	45	----	Downtown Clayton
64	Lucas Hunt	6:00 AM - 10:13 PM	6:45 AM - 7:33 PM	7:44 AM - 6:36 PM	30	30	60	Big Bend/Millbrook, Downtown Clayton
66	Maplewood-Airport	5:27 AM - 8:47 PM	7:16 AM - 7:41 PM	----	30	60	60	Downtown Clayton
68	Big Bend	5:40 AM - 7:00 PM	5:40 AM - 7:00 PM	5:40 AM - 7:00 PM	30[12]	60	----	Shrewsbury, Delmar
90	Hampton	3:59 AM - 1:20 AM	5:15 AM - 1:02 AM	5:20 AM - 12:29 AM	15	30	60	Forest Park[1]
91	Olive	4:59 AM - 11:23 PM	5:46 AM - 11:38 PM	9:03 AM - 8:51 PM	20	30	60	Downtown Clayton[13]
92	Lindenwood	5:08 AM - 11:44 PM	5:30 AM - 9:51 PM	8:21 AM - 8:09 PM	30	60	60	Lansdowne Avenue
93	Lindell	4:35 AM - 1:20 AM	5:11 AM - 1:28 AM	6:29 AM - 10:01 PM	20	20	40	Forest Park[1], Skinker/Millbrook, Downtown Clayton
95	Kingshighway	4:58 AM - 1:03 AM	4:53 AM - 1:22 AM	5:16 AM - 12:31 AM	10	15	30	Central West End[1]
97	Delmar	4:20 AM - 1:25 AM	4:53 AM - 12:25 AM	5:09 AM - 11:29 PM	15	15	30	Big Bend/Millbrook, Downtown Clayton, Forest Park Parkway
98	McCausland-Delor	6:35 AM - 7:13 PM	----	----	60	60	----	Shrewsbury
191	Chesterfield Valley Connector[5]	5:59 AM - 6:53 AM; 3:40 PM - 6:32 PM	----	----	55	----	----	Downtown Clayton
657	Maplewood Limited[8]	7:21 AM - 9:02 AM; 3:37 PM - 5:03 PM	----	----	10	----	----	Manchester Road
Express Routes								
11X	Shrewsbury Express[9]	6:25 AM - 8:59 AM; 3:38 PM - 6:12 PM	----	----	20	----	----	Lansdowne Avenue
57X	Ellisville Express	5:39 AM - 7:54 AM; 4:03 PM - 6:37 PM	----	----	30-40	----	----	
111X	Kirkwood Express[9]	6:01 AM - 8:25 PM; 4:13 AM - 6:33 PM	----	----	30	----	----	Lansdowne Avenue
152X	Highway 40-Clayton Rd. Express	5:45 AM - 8:16 AM; 4:04 PM - 7:04 PM	----	----	20-30	----	----	
157X	Manchester Road Express[9]	5:55 AM - 8:16 AM; 4:13 PM - 6:14 PM	----	----	30	----	----	Manchester Road
357X	Twin Oaks Express	5:39 AM - 8:30 AM; 3:48 PM - 6:56 PM	----	----	20-30	----	----	Lansdowne Avenue
457X	Fenton Express[8]	5:08 AM - 7:54 AM; 2:40 PM - 5:42 PM	----	----	60	----	----	Lansdowne Avenue
NEW ROUTES								
Shuttle Routes								
	McKnight/Univ. City Shuttle	5:00 AM - 1:00 AM	5:00 AM - 12:00 Midnight	6:00 AM - 12:00 Midnight	15	15	30	Delmar[1]
	Brentwood Shuttle	5:00 AM - 1:00 AM	5:00 AM - 12:00 Midnight	6:00 AM - 12:00 Midnight	15	15	30	Downtown Clayton, Galleria
Route Deviation								
	Dale Limited	6:00 AM - 9:00 PM	8:00 AM - 7:00 PM	8:00 AM - 7:00 PM	20	30	30	Eager Road or Galleria
Regular Route								
	McKenzie-Gravois	5:30 AM - 7:00 PM	----	----	40	60	----	Lansdowne Avenue
Community Feeder Routes[14]								
	Webster Groves	5:30 AM - 7:30 PM	----	----	40	60	----	Lansdowne Avenue
	Crestwood	5:30 AM - 7:30 PM	----	----	40	60	----	Lansdowne Avenue
	Grantwood Village	5:30 AM - 7:30 PM	----	----	40	60	----	Lansdowne Avenue
	Marlborough	5:30 AM - 7:30 PM	----	----	40	60	----	Lansdowne Avenue
	Affton	5:30 AM - 7:30 PM	----	----	40	60	----	Lansdowne Avenue
	Sappington/Concord	5:30 AM - 7:30 PM	----	----	40	60	----	Lansdowne Avenue
	Butler Hill	5:30 AM - 7:30 PM	----	----	40	60	----	Lansdowne Avenue

1. This Metrolink connection already exists
2. Representative of service later than 7:00 P.M.
3. Peak and off-peak headways are 40 and 60 minutes, respectively, north of the route split at Hord
4. Headways shown approximate existing conditions for existing service
5. Operates with a single westbound trip in morning and two eastbound trips in the afternoon, running 55 minutes apart
6. Northbound service operated during the morning peak, southbound service operated during the afternoon peak
7. Offers approximately 30 minute headways during the morning peak and 60 minute headways during the afternoon peak
8. Offers westbound service during the morning peak and eastbound service during the afternoon peak
9. Offers eastbound service during the morning peak and westbound service during the afternoon peak
10. Hours shown are from the inception of the first buses route to the completion of the last buses route, modified from existing schedules if necessary
11. Operates with 60 minute headways between West County Center and Clarkson/Clayton
12. This route would operate only between the Delmar station and the Rock Hill loop on Sundays, with a peak headway of 45 minutes
13. If direct service from downtown St. Louis to downtown Clayton is unavailable via Metrolink, then this route retains its existing alignment (connection at Delmar)
14. Community feeder routes have peak period from 5:30 AM to 9:30 PM and 3:30 PM to 7:30 PM; during AM peak operate express (closed door) from respective community to MetroLink station but open door on reverse trip; for PM peak period operate express (closed door) from MetroLink station to community but open door on reverse trip
15. Existing operations to be changed as part of the Forest Park Circulator Plan.

(1) Forest Park Station - 4 Routes
#90 Hampton
#93 Lindell
Forest Park Circulator (two potential routes)

(2) Skinker Boulevard at Millbrook Boulevard - 2 Routes
#16 City Limits
#93 Lindell

(3) Big Bend Boulevard at Millbrook Boulevard - 2 Routes
#64 Lucas - Hunt
#97 Delmar

(4) Forsyth Boulevard (east downtown Clayton - 3 Routes)
#63 Clayton N. W. Plaza
#68 Big Bend
#97 Delmar

(5) Downtown Clayton at Carondelet Avenue - 11 Routes[5]
#47 Cross-County
#53 Litzinger
#63 Clayton N.W. Plaza
#64 Lucas Hunt
#66 Maplewood Airport
#68 Big Bend
#91 Olive
#93 Lindell
#97 Delmar
#191 Chesterfield Valley Connector
New Brentwood Shuttle Route

As part of the downtown Clayton transit improvements, the Clayton Transit center will be implemented. This includes facilities for bus transfers in the core of downtown Clayton along Meramec Avenue between Carondelet Avenue and Forsyth Boulevard. This location links directly with the potential MetroLink station associated with the Carondelet Avenue alignment alternatives. The transit center would include streetscape and various passenger amenities.

[5] None of these routes would directly access the potential station location on Forest Park Parkway between Central and Meramec Avenues.

Transit service includes the new Brentwood shuttle. This shuttle would serve the major shopping centers, office buildings, and other commercial land-uses located along Brentwood Boulevard from Clayton south into the city of Brentwood. This route will expand the accessibility of MetroLink to these major trip attractions.

(6) Galleria - 6 routes[6]
#47 Cross-County
#52 Forest Park
#58 Clayton - Ballas
#62 Kirkwood - Clayton - Wellston
#191 Chesterfield Valley Connector
New Brentwood Shuttle Route

(7) Eager Road - 2 Routes
#47 Cross-County
New Dale Limited Route

This service includes a new Dale Avenue route. It would provide a connection from the St. Mary's Hospital complex on Clayton Road (east of Skinker Boulevard) thru sections of Richmond Heights, Maplewood, and Clayton to the Eager Road MetroLink station. This would operate as a route deviation service in which riders could arrange for front-door pick-up/drop-off. The basic route would follow Bellevue Avenue from Clayton Road (Hospital Site) south to Dale Avenue and west on Dale Avenue to the MetroLink station. Its service area would extend 0.50 mile north and south of the basic route (this area is roughly bounded by Clayton Road to the north and Bruno Avenue to the south). Deviations in this service could add 5 to 10 minutes to the travel time along the basic route. Such added time would be anticipated in the schedule for the service. It would require setting up a call-in/demand response communications element with appropriate advertisement in the community.

(8) Manchester Road - 5 Routes
#21 Tower Grove
#47 Cross-County
#57 Manchester
#157X Manchester Road Express
#657 Maplewood Limited

[6] These routes are all located on Brentwood Boulevard. Only #52 Forest Park is on Clayton Road. The latter may be the only route with direct access to the CMT right-of-way station location. The new Brentwood Shuttle could be routed to this location as well.

(9) Laclede Station Road[7] at Hanley Road - 3 Routes
#16 City Limits
#47 Cross-County
#68 Big Bend
Routes #16 and #18 operate on Big Bend Boulevard. They would be routed thru the Sunnen Business Park to Hanley Road to connect to this station.

(10) Big Bend Boulevard[7] at Oxford Boulevard - 3 Routes
#16 City Limits
#47 Cross-County
#68 Big Bend

(11) Deer Creek[8] - 12 Routes
#16 City Limits
#47 Cross-County
#68 Big Bend
#357X Twin Oaks Express
New Mackenzie - Gravois Route
Seven new community feeder routes (Webster Groves, Crestwood, Grantwood Village, Marlborough, Affton, Sappington/Concord, and Butler Hill)

(12) Shrewsbury[9] at Lansdowne Avenue - 17 Routes
#11 Chippewa (East)
#11 Chippewa (West)
#11X Shrewsbury Express
#17 Clayton - Oakville
#92 Lindenwood
#98 McCausland
#111X Kirkwood Express
#357X Twin Oaks Express
#457X Fenton Express
New Mackenzie - Gravois Route
Seven new community feeder routes (Webster Groves, Crestwood, Grantwood Village, Marlborough, Affton, Sappington/Concord, and Butler Hill)

---

[7] These two stations are alternates; only one would be include in the MetroLink project.

[8] This station is an alternate with the Lansdowne Avenue station; only one of these two would be constructed as part of this MetroLink project.

[9] Ibid

This pattern of MetroLink/bus interchange creates increased accessibility for travelers in the Cross-County corridor and beyond. It should be noted that substantial interfacing would occur at the potential south station at Lansdowne Avenue in Shrewsbury. Seventeen routes would connect to MetroLink.

The pattern of these routes creates accessibility for travel in the traditional "inbound" (towards Clayton and downtown St. Louis) but also outward from the region's center to the south/southwest suburban area. This will enhance mobility relative to "reverse commute" opportunities.

Specifically, the bus routes will provide accessibility in several corridors and most of the communities between the MetroLink line and I-270 (south of I-44):

- Murdoch/Lockwood/Adams to the west
- Chippewa/Watson to the east and west
- I-44/Big Bend to the west
- I-44 to the west (access to Chrysler plant)
- Murdoch/Laclede station to the south
- New route Mackenzie/Gravois to the south and southwest

For the above services, the line haul and express service will involve use of the standard BSDA vehicles, i.e., 35' and 40' vehicles with seating capacities of 37 and 45 passengers, respectively. For the two shuttle routes and community feeder routes, smaller vehicles with seating capacity in the 15 to 25 person range would be used.

Stops and Stations

An important part of the plan concerns the facilities associated with stops and stations. For the bus routes, "flag" stops are currently used in which buses will stop at any location, providing it is safe to do so. This policy will continue for the services identified in this plan.

The MetroLink stations will represent new locations for bus stops. Depending upon MetroLink design concept, some stops will be within public street right-of-way (on-street) and others will be off-street.

Specific operations at proposed MetroLink stations will be as follows:

1. Forest Park Station
   Same facilities as existing, bus stops along DeBaliviere Avenue

2. Skinker Boulevard Station
   a. At-grade MetroLink (median)
      Bus stops on street along Skinker Boulevard, near side approaches at Forest Park Parkway, for northbound and southbound buses.
   b. At-grade MetroLink (south edge)
      Bus stops for the Skinker Boulevard routes would be near side (northbound) and far side (southbound) at the LRT tracks; all stops with one bus capacity.
   c. Below-grade MetroLink
      Bus stops on street along Skinker Boulevard, near side approach at Forest Park Parkway, (northbound) and far side (southbound); space in each bus stop will be for one bus.

3. Big Bend Boulevard Station
   a. At-grade MetroLink (station only in median)
      Bus stops will be on street along Big Bend Boulevard and will be in near-side locations with space for one bus.
   b. Below Grade MetroLink
      Bus stops will be on street along Big Bend Boulevard and will be in near-side locations with space for one bus.

4. Forsyth Boulevard at Forest Park Parkway
   All stops on Forsyth Boulevard west of LRT tracks, with one bus capacity.

5. Downtown Clayton (Carondelet - Central to Meramec)
   Bus stops combined into new bus transfer facility on east side of Meramec Avenue north of Carondelet Avenue with capacity for up to 7 buses. This will be both at-grade and below grade Carondelet Avenue MetroLink.

6. Forest Park Parkway at Meramec/Central Avenue
   Bus stops combined into new bus transfer facility on east side of Meramec Avenue north of Carondelet Avenue with capacity for up to 7 buses. This will be both at-grade and below grade Carondelet Avenue MetroLink. There is a possibility that a transfer facility could be incorporated into a proposed St. Louis County parking garage along Shaw Park Drive between Central and Meramec. Bus routes could be modified to access this location in addition to stopping along Meramec Avenue in the downtown core.

7. Galleria Station on CMT Right-of-Way
   Access to station via drive from Clayton Road (at Crescant Drive) immediately east on CMT right-of-way; facility would have capacity for one bus. Some consideration could be given to a bus stop location along the east side of the CMT right-of-way at the east end of Galleria Parkway. This could be an off-street drive with space for up to four buses.

8. Galleria Station Underground along Brentwood Boulevard
   Bus stops to near side of Brentwood Boulevard (southbound) and far side on Brentwood Boulevard (northbound) at Galleria Parkway. Bus stop to have three bus capacity.

9. Galleria Station elevated, parallel and east of Brentwood Boulevard
   Bus stops to be same as noted for Galleria - Brentwood Boulevard.

10. Eager Road at CMT Right-of-Way
    Bus stop will be new off street facility accessed from Hanley Road and Eager Road. Two bus berths will be provided.

11. Manchester Road at CMT Right-of-Way
    Bus stop will be new off-street facility accessed from Manchester Road (just east of CMT). Two bus berths will be provided.

12. Laclede Station Road at Hanley Road
    Bus stop will be a new off-street facility accessed from Hanley Road. Two bus berths will be provided.

13. At-grade MetroLink at Big Bend Boulevard
    Bus stop will be in new off-street facility accessed from Oxford Boulevard. Two bus berths will be provided.

14. Elevated or at-grade MetroLink at Deer Creek (east of Big Bend Boulevard, south of Oxford Avenue)
    Bus stop will be new off-street facility access via Oxford Avenue. Eight bus berths will be provided.

15. Elevated MetroLink at Lansdowne Avenue
    Bus stop will be in new off-street facility. Ten bus berths will be provided.

Need for Preferential Facilities

The bus services, recommended in this plan, will primarily operate in mixed traffic. It is not anticipated that any preferential facilities will be needed. Each bus stop, whether on-street or off-street, would be a preferential or protected space for buses only. The major bus transfer facility in downtown Clayton would also be a preferential space.

The only other exception could be new ramp access at I-44 for the southern MetroLink station. Among the options being considered is a pair of preferential ramps to and from the west for I-44. These ramps could be restricted to buses and car-pool/van-pool vehicles.

5
Traffic Management

The final element of the preliminary operations plan describes traffic management in and around the MetroLink alignment, stations, and facilities. By definition, traffic management concerns vehicle and pedestrian traffic directly associated with MetroLink operations (i.e., riders and the general traveling public who would be affected by MetroLink operations).

The need for traffic management, as defined above, comes about because of the characteristics of the Cross-County MetroLink Extension project. First, the project will include a series of stations to which a significant number of people will be attracted. They will walk, ride a bike, drive, be dropped off, or ride a bus to these stations. These actions will require access facilities and associated traffic management.

Secondly, the design of the Cross-County MetroLink Extension will be selected from a range of conceptual design alternatives. Among these alternatives are at-grade concepts in which MetroLink will be located in existing public street rights of way. While the tracks will have their own reserved space, MetroLink trains and other traffic will intersect at various locations. MetroLink tracks could also affect access to land-use.

It is for the above situations that a traffic management plan has been developed. In the following sections of this chapter, the features of traffic management are discussed in relation to MetroLink station access and at-grade operations in the public street right-of-way.

MetroLink Station Access

Station access is needed for passengers and those serving passengers. These needs will be addressed as follows:

1. Forest Park Station (below grade alignment)
   a. Bus transfer and drop-off/pick-up facilities will be located north of Forest Park Parkway along each side of DeBaliviere.
   b. Existing parking lot (along DeBaliviere Avenue) may be modified as part of a BSDA planned development project, with vehicle access via DeGiverville/Pershing /DeBaliviere intersection.
   c. Pedestrian access to station platforms to be available on each side of DeBaliviere at the north edge of the MetroLink bridge.
   d. Sidewalks to be widened as part of new DeBaliviere bridge with marked cross walks across Forest Park Parkway to the south.

2. Skinker Boulevard Station (underground, at-grade /median, at-grade/south alternatives)
   a. Drop-off/pick-up space located on west side of Skinker Boulevard south of Forest Park Parkway.
   b. No off-street parking; no on-street parking in any intersection approach.
   c. For at-grade/median alternative, direct station pedestrian access will be via marked cross-walks parallel to Skinker Boulevard; for the at-grade/south alternative, direct pedestrian access will be via the south sidewalk along Millbrook Boulevard, just west of Skinker Boulevard; for the underground alternatives, stairway/elevator access will be available along south side of Millbrook Boulevard, west of Skinker and at the northwest corner of Skinker/Forest Park Parkway.

3. Big Bend Boulevard (underground, at-grade /median alternatives)
   a. Drop-off/pick-up space should be provided along the curb lane on Big Bend Boulevard in the north approach (for southbound traffic) and south approach (for northbound traffic); however, high traffic volumes will preclude this function except during non-peak hours.
   b. No off-street parking; no on-street parking in any intersection approach.
   c. For at-grade/median alternative, direct station pedestrian access will be via marked crosswalk parallel to Big Bend Boulevard; for the at-grade/south alternative, the station will be underground with stairway/elevator access provided along the south side of Millbrook Boulevard east of Big Bend Boulevard and to the northeast corner of Millbrook/Big Bend; for the underground alternative, the station is in center of Millbrook Boulevard right-of-way, stairway and elevator access will be linked to the south side of Millbrook Boulevard east of Big Bend Boulevard and to the northeast corner of Millbrook/Big Bend.

4. Carondelet Plaza Station (east downtown Clayton) (underground and at-grade alternatives)
   a. Drop-off/pick-up space on-street along Carondelet Plaza south of Forsyth Boulevard.
   b. No off-street parking to be provided except it is recognized that there is off-street parking available in the downtown (for a fee) that MetroLink riders could use. On-street parking in vicinity is provided, but for short-term use.

c. At-grade pedestrian access to be provided directly from the sidewalk along the north side of Carondelet Plaza (just south of Forsyth); access the underground station will be available from Carondelet Plaza (south of Forsyth) and from the Forsyth Boulevard sidewalk area (just east of Carondelet Plaza).

5. Downtown Clayton/Carondelet Avenue Station (underground and at-grade alternatives)
   a. No off-street parking to be provided except there is a substantial downtown parking system that could be used by MetroLink riders (to the extent space will be available) including new facilities being planned and under construction by St. Louis County and City of Clayton; on-street parking is available in vicinity, but it is for short-term use.
   b. Drop-off/pick-up space available along east side of Meramec Avenue north of Carondelet or west side of Central avenue north of Carondelet; the space on Meramec would be positioned to be coordinated with the potential new BSDA bus transfer facility being considered for the block between Carondelet and Forsyth Boulevard (east side of Meramec).
   c. At-grade pedestrian access will be provided via the existing downtown sidewalk system; some modification of the cross-walk will occur in the Central/Carondelet Avenue intersection because of changed street elevations due to MetroLink tracks (i.e., for the at-grade alternative, possibly lowering of street elevation and repositioning of crosswalks); Carondelet Avenue between Central and Meramec will become an auto-free zone with a pedestrian plaza and MetroLink platforms (for the at-grade alternative) or MetroLink stairway/elevator access (for the underground alternative).

6. Forest Park Parkway at Meramec - Central Station[10] (elevated alternative)
   a. No off-street parking with the possibility that MetroLink riders might be able to use the planned St. Louis County garage on evening and weekends.
   b. Drop-off/pick-up space would be available along Shaw Park Drive.
   c. As an elevated station, pedestrian access required stairway/elevators connection to the platform. These connections will extend over Shaw Park Drive to the north side of the street with the principal linkage being a north-south pedestrian way located on Central Avenue adjacent to the east edge of the proposed county parking garage; this will be a level passage that would begin as a second level walkway (at Shaw Park Drive) and come to ground at a mid-point (between Shaw Park Drive and Bonhomme). There could also be a new pedestrian bridge over Forest Park Parkway that would link the neighborhoods to the south to the MetroLink station.

7. Galleria/CMT Right-of-Way Station[11]
   a. No off-street parking or on-street parking available.

---

[10] This station is an alternative to stations #4 and #5.

[11] This is one of three stations associated with the at-grade, underground, and elevated alternatives for the Galleria Area; one will be selected.

b. Drop-off/pick-up space via new station access drive linked to Galleria Parkway west of the CMT.

c. Pedestrian access would be available in three directions - to east at-grade into the commercial area and Crescent Drive (to Clayton Road), to south via ped/bike path to the residential area along and east of Linden Avenue, and to west via an improved pedestrian way along Galleria Parkway under I-170 to Brentwood Boulevard.

8. Galleria/Brentwood Boulevard Station (underground alternative)[12]

a. No off-street parking or on-street parking.

b. Drop-off/pick-up space in bay along Brentwood Boulevard - both sides north of Galleria Parkway.

c. Pedestrian access will be directly to the sidewalks along Brentwood Boulevard; improved crosswalk would be placed across Brentwood to line-up with the access drive (signalized intersection) to the University Club Tower building site; and possibly a marked pedestrian path in the Galleria Shopping Center site leading to doorways (Dillards Department store or other entrances).

9. Galleria east of Brentwood Boulevard Station (elevated alternative)[14]

a. Possible new off-street parking with joint development; no on-street parking.

b. Possible drop-off/pick-up stopping space in off-street facility in site north of Galleria Parkway, east of Brentwood Boulevard.

c. In concept, the station would be part of a joint development project. As such, pedestrian access would be integrated with the development. This could also include a possible pedestrian skywalk over Brentwood Boulevard to enhance the linkage to the Galleria Shopping Center.

10. Eager Road/CMT Right-of-Way Station

a. New major park-n-ride facility providing 1000 or more spaces[13], no on-street parking will be available.

b. Drop-off/pick-up space will be available along new site access drive parallel to east side of station.

c. Arterial street access to the site will be available from Hanley Road via a connection (and extension) at Dale Avenue through an existing development area (easement or right-of-way to be obtained); another access drive is possible from Eager Road at a point east of the CMT overpass, this drive could be part of new development.

---

[12] Ibid

[13] Parking demand approximate pending results of travel demand forecasts being provided by others.

d. Pedestrian access would be provided at-grade to areas east and west of the station; the former would link to Hanley Road while the latter would link into a major development area.

11. Manchester Road/CMT Right-of-Way Station
    a. No off-street parking or on-street parking.
    b. Drop-off/pick-up space would be provided in off-street facility north of Manchester Road just east of the CMT right-of-way; Manchester Road would be widened to include a left turn lane to serve the site.
    c. Because the CMT is elevated over Manchester Road stairs/elevators will be located north of Manchester Road to provide the linkage between the platform and ground level; there will also be a connection from the south end of the platform directly into the Sunnen Corporation site (which is also above the Manchester Road elevation); improved sidewalks will be provided along the north side of Manchester Road to Hanley Road.

12. Laclede Station Road at Hanley Road Station (at-grade/elevated alternative)[14]
    a. No off-Street or on-street parking to be provided.
    b. Drop-off/pick-up off-street facility to be provided along west side of Hanley Road near existing Laclede Station Road intersection.
    c. Pedestrian access will be at-grade to the north of the station linking the business park, potential new development, and the neighborhood to the north; stairs/elevations or ramps to be provided at south end of station to provide access down to Hanley Road and to areas south/west.

13. Big Bend Road Boulevard/CMT Right-of-Way Station[15]
    a. A small parking facility with 100 spaces could be provided on a site at the northwest corner of Big Bend Boulevard/Oxford Boulevard; this site could also be used for development; or an agreement could be reached with the owners of the Deer Creek Center to use existing shopping center parking; no on-street parking available.
    b. Drop-off/pick-up space would be included; access would be via a drive from Oxford Boulevard.
    c. Pedestrian access would directly link to the sidewalk on Big Bend Boulevard and westward into the Deer Creek Center; possibly, a pedestrian way could be extended north along the CMT (under the U.P. Railroad) and up into the business park.

---

[14] Stations #12 and #13 are alternates - only one will be selected.

[15] Ibid

14. Lansdowne Avenue Station[16]
    a. New major off-street parking facility would be provided with over 800 spaces[17].
    b. Drop-off/pick-up space would be provided; access would be developed at the existing Lansdowne Avenue/River Des Peres Boulevard intersection (i.e., create north leg to this intersection); and possibly via new ramps from I-44 as part of freeway corridor improvements (by Missouri Department of Transportation).
    c. Pedestrian access, via stairs/elevators, would be located north of Lansdowne east of the tracks to link the platform to ground; there would be a secondary set of stairs/ramp on the south side of Lansdowne Avenue; all of this access would connect to sidewalks on Lansdowne providing linkages into Shrewsbury to the west and St. Louis to the east and south.

15. Deer Creek/CMT Right-of-Way Stations (at-grade and elevated alternatives)[18]
    a. New major off-street facility would be provided with over 800 spaces[19].
    b. Drop-off/pick-up space would be provided within the site; access would be via Oxford Avenue linked to the Big Bend Boulevard/Oxford Boulevard intersection.
    c. Pedestrian access would be directly to the Big Bend Boulevard/Oxford Boulevard/Oxford Avenue intersection with crosswalks to the west and north; the Big Bend Boulevard sidewalk would provide linkage to the areas south of Deer Creek.

At-Grade Operations

As described at the beginning of this chapter, at-grade alternatives are included among the set of candidate alternatives being considered for the Cross-County MetroLink Extension. For Segment I of the Cross-County corridor, at-grade alternatives could be implemented in the following locations:

1. Along Forest Park Parkway and Millbrook Boulevard from a point west of DeBaliviere Avenue to a point west of Big Bend Boulevard.

2. In downtown Clayton from Forsyth Boulevard (near Forest Park Parkway) along Carondelet Plaza, Carondelet Avenue, and Meramec Avenue or Brentwood Boulevard to Forest Park Parkway/Shaw Park Drive.

---

[16] Station #14 and #15 are alternates - only one will be selected.
[17] Approximate quantity pending results of travel demand forecasts by others.
[18] Stations #14 and #15 are alternates - only one will be selected.
[19] Approximate quantity pending results of travel demand forecasts by others.

3. In the vicinity of Laclede Station Road, the alignment follows the CMT right-of-way into the Laclede Station Road right-of-way crossing Flora Avenue and Sunnen Drive at-grade.

4. In the vicinity of the Big Bend Boulevard/Oxford Avenue intersection in which MetroLink would be located in the CMT right-of-way crossing both Big Bend Boulevard and Oxford Avenue at-grade.

The specific operational/physical improvements associated with MetroLink LRT service will be coordinated with owners of the street system. It is this relationship that the traffic management element of the operations plan addresses.

In the following sections, the preliminary traffic management plan is described. The description is organized in the following manner:

- Initially, certain basic considerations are discussed. These set the context or framework for traffic management by highlighting certain realities about the Cross-County corridor.

- Next, the discussion sets forth various traffic management principles. These define key priorities for traffic management. Inasmuch that MetroLink is being introduced into a largely built-up urban area, there will be the need to make modifications in both space (e.g. use of right-of-way) and time (e.g., intersection signal phasing). These principles provide guidance about making these accommodations.

- With the framework and guidance provided by the considerations and principles, the remaining sections present the details of the traffic management plan. The lead section describes traffic management policies. These policies include reference to national standards for traffic management plus a series of operational policies that would be employed in the Cross-County corridor. The second section of the traffic management plan provides the details for site-specific recommendations concerning street geometric design and traffic operations, traffic controls, and land-use access.

Basic Considerations

There are certain key facts about the Cross-County corridor that serve as basic considerations for traffic management.

1. Major street capacity can be expanded only marginally. No new major regional or city-wide routes within the proximity of or affecting this project are likely in the future.

2. Within the Cross-County corridor, a principal physical resource for the MetroLink location is the network of public street rights-of-way. Because of the extent of existing and committed land-use and development, and the value of these land-uses, the opportunity to add new rights-of-way or expanding them is limited. The right-of-way network is largely a fixed resource.

3. The downtown Clayton street system has a grid configuration. Access and circulation become less dependent on single streets, but rather several streets operating in combination with each other. This provides flexibility for vehicle circulation and access.

4. Historically, only a portion of the available street capacity in downtown Clayton has been used for traffic movement. There is, additional capacity via converting more curb parking lanes into a traffic movement function.

5. Along Forest Park Parkway and Millbrook Boulevard, there are very few driveways and local street intersections. These conditions promote good traffic performance. Within downtown Clayton, there are substantially more driveways and closely spaced local intersections. Traffic flows in downtown are slower.

6. Existing peak hours traffic volumes vary substantially within the corridor. Table (4) summarizes existing volumes for most of the intersections affected by at-grade MetroLink operations. These volumes have been used as input to this preliminary operations plan. Adjusted volume information[20], reflecting potential future traffic growth (yr. 2020), will be used for the final operations plan.

   The implication of these existing peak volumes is that Forest Park Parkway, Skinker Boulevard, Millbrook Boulevard, and Hanley Road have high volumes with per lane volumes in the range of 600 to 800 vehicles per hour per lane.

   Other streets, affected by at-grade MetroLink operations, have very low volumes. These streets experience volumes in the 100 to 300 vehicles per hour per lane range.

Traffic Management Principles

Along with the considerations, described above, the formulation of traffic management concepts has been guided by a set of principles.

The overall principle is to manage traffic to serve the greatest number of people in convenient and safe ways. Specific principles consistent with this broad perspective are as follows:

---

[20] Being prepared by others as part of travel demand forecasts.

Table 4 Existing Peak Hour Traffic Volumes

INTERSECTION		DIRECTION											
		SOUTHBOUND			WESTBOUND			NORTHBOUND			EASTBOUND		
		RT	Thr.	LT	RT	Thr.	LT	RT	Thr.	LT	RT	Thr.	LT
Forest Park Parkway	AM	105	70	65	5	615	60	25	45	100	5	1200	5
@ Des Peres	PM	45	35	50	5	1030	60	10	105	80	15	1235	5
Forest Park Parkway	AM	270	860	220	45	720	55	55	715	150	175	940	50
@ Skinker	PM	115	625	120	45	1025	85	95	880	265	245	1040	185
Millbrook	AM	NA	NA	NA	NA	1065	20	10	NA	15	85	1255	NA
@ Hoyt	PM	NA	NA	NA	NA	1325	50	70	NA	105	65	1460	NA
Millbrook	AM	125	455	285	55	925	50	55	410	215	135	970	90
@ Big Bend	PM	60	525	180	355	1200	140	85	630	265	125	1275	150
Millbrook	AM	NA	NA	NA	NA	1115	25	10	NA	15	85	1255	NA
@ Throop	PM	NA	NA	NA	NA	1410	20	65	NA	155	65	1345	NA
Hanley	AM	65	570	25	20	125	140	135	960	320	145	205	60
@ Carondelet	PM	70	980	35	65	70	90	125	870	145	30	320	185
Bemiston	AM	15	125	55	60	120	60	75	95	15	50	160	50
@ Carondelet	PM	40	135	55	55	145	80	50	110	25	25	165	20
Central	AM	0	145	30	40	0	85	105	160	0	0	0	0
@ Carondelet	PM	0	175	25	105	0	105	75	120	0	0	0	0
Meramec	AM	25	100	0	0	0	0	0	40	20	85	0	50
@ Carondelet	PM	30	175	0	0	0	0	0	110	30	85	0	65
Meramec	AM	45	70	65	85	260	50	65	110	65	60	355	60
@ Bonhomme	PM	110	165	115	45	195	30	45	70	30	40	125	50
Carondelet	AM	NA	435	85	45	NA	25	95	705	NA	NA	NA	NA
@ Brentwood	PM	NA	825	50	85	NA	95	20	420	NA	NA	NA	NA

Source: Parsons Transportation Group - November, December, 1998 & March, 1999

1. Traffic performance

   Street traffic flow will be maintained at reasonable levels of service, as defined by level of service D per the Highway Capacity Manual (see Table 3). There would be an exception in those cases when level of service (existing or future) would already exceed this standard (without MetroLink included). In these cases, the intent would be to minimize further reduction in level of service.

2. Transit pedestrian priority

   Transit and pedestrian movements will have priority over auto movements. This means that for some unavoidable situations where all traffic movements (general traffic, MetroLink, pedestrian) can not be fully accommodated, the trade-off will be towards MetroLink and pedestrians. Both of these modes will provided sufficient physical space for safe functions; traffic controls would be adjusted provide proper clearance times in intersections. A major implication of this priority will be that at signalized intersections, MetroLink will have traffic signal priority. This would employ full signal preemption or signal prioritization concepts. The application of the specific control strategy will depend upon site-specific conditions.

3. Exclusive light rail lines

   MetroLink will operate on tracks located in exclusive space within the public street right-of-way (existing and with any added right-of-way per the conceptual design for the alternatives). By definition, this means that other traffic will not travel along the MetroLink tracks. Other traffic will be allowed to cross the tracks at various points under managed conditions.

4. Travel priority

   Considering the use of available public right-of-way (existing plus any added space), priority will be given to the movement of vehicles over parking, loading, and similar uses.

Traffic Management Policies

With the principles as a guide, the following policies are recommended for Cross-County corridor. These have been used to develop site specific recommendations for traffic management.

1. Standards

   Traffic management will be guided by the following standards of practice:

   - Manual on Uniform Traffic Control Devices for Streets and Highways, Federal Highway Administration, 1988 with recent updates

- Railroad-Highway Grade Crossing Handbook, Federal Highway Administration, 1985
- Institute of Transportation Engineers Technical Committee Reports concerning Standards of Practice
  - Committee #6Y-37, Guidelines for Design of LRT Crossings, 1992
  - Committee #6A-42, LRT Grade Separation Guidelines, 1993
- Highway Capacity Manual, Transportation Research Board, 1994

Also, it is anticipated that there may be additional standards to be considered as promulgated by appropriate authorities. Such standards, if different or additive to the above national standards, would be incorporated at a later date in the project.

2. Traffic Operations
   a. Existing streets will not be closed to traffic flow by MetroLink.
   b. Traffic lanes on arterial streets will be 11 to 12 feet wide; some traffic lanes on local streets can be narrowed to 10 feet to maintain sidewalk widths for pedestrian activity.

3. Traffic Control-Signals
   a. All public street intersections crossed by MetroLink at-grade will be signalized.
   b. Signals will be controlled by local controllers at isolated intersections or within the coordination of closed loop signal systems. Signals will be managed according to local jurisdiction in coordination with BSDA.
   c. At locations where MetroLink crosses through intersections, signal phases will generally provide for train movements concurrent with auto and pedestrian traffic on the parallel street; this will aid MetroLink speed and minimize general traffic delay.
   d. At locations where MetroLink crosses streets other than intersections, crossings will be controlled by crossing gates and signals. The exceptions will be for locations with low traffic flow or where safety considerations allow for other controls.
   e. Intersections will have left turn lanes, controlled by left turn signal phases; permissive left turns across MetroLink tracks will be prohibited.

4. Pavement Markings and Signs
   a. Motorists will be deterred from traveling along MetroLink tracks thru the use of barrier medians and by use of special pavement materials (texture and color) in conjunction with mountable medians. In those locations without barrier medians, elongated white diamond striping will be used in the MetroLink track lanes plus other signage to inform motorists that vehicle traffic is prohibited.
   b. In sections parallel to tracks, vehicle lanes will be striped to channel traffic into appropriate paths; excess and unmarked pavement will be minimized to maintain proper control.

c. Special signs will be used to remind motorists of the presence of MetroLink tracks in the streets.
d. Illuminated “NO LEFT TURN” and “NO RIGHT TURN” signs will be used at all intersections with MetroLink at-grade.
e. Low clearance signs will be used where MetroLink wire heights would be less than 16 feet.

5. Pedestrian Activity
   a. Traffic signal phasing will incorporate sufficient pedestrian crossing time for persons to safely walk across the street.
   b. Sidewalk widths accommodate peak pedestrian movement volumes at projected levels.
   c. Pedestrian movements are managed so that they occur at intersection crosswalks.

6. Property Access
   a. Emergency vehicle, maintenance, and service access will be maintained or otherwise provided, as necessary, along streets affected by MetroLink.
   b. While achieving policy “a”, access to land-use can be adjusted in various ways to accommodate both MetroLink and the normal activities associated with land-uses along streets where tracks may be installed. These access modifications could include:
      - Access to all properties will be maintained. To minimize conflict with MetroLink operations, access points may be relocated to other streets or alleys where possible; or permitted across MetroLink tracks if necessary.
      - Where driveway access is retained, access will be managed using various techniques: time management, by field personnel, controlled by signals or guided by signs and markings; the specific action will be developed on a site basis.
      - Public alley access may be modified to minimize conflicts with MetroLink operations; this could consider relocation of alley access, using one-way operations, or realignment of alleys.
      - On-street loading/service zone may be relocated, provided via a recessed bay, served by time management or new off-street loading space may be created.
   c. Plans for future developments should refrain from creating new access locations requiring crossing of MetroLink tracks.

7. Safety

   For each of the preceding features, safety is an overriding consideration. The keys to a safe operating environment for MetroLink and adjacent traffic operations are:
   a. Clear operating conditions (no confusion or ambiguity).

b. Reasonable operating speed for MetroLink and general traffic in relation to stopping distances.
c. Appropriate visibility for pedestrians and motorists to see MetroLink trains and all other traffic movements.
d. Measures (via added signs) to maintain awareness of MetroLink along streets with tracks.
e. Education program to support safe operating practices.
f. As noted above use of illuminated "No Left Turn" and "No Right Turn" signs to emphasize the presence of MetroLink trains.

8. Enforcement
   a. Enforcement activities focus on three types of actions:
      - Preventing encroachment onto MetroLink tracks
      - Observing traffic signal controls at intersections
      - Observing no parking, stopping or standing signs, as required, along the at-grade track alignment.
   b. At traffic signal locations in downtown Clayton, a critical issue will be managing pedestrian flow. At downtown and other locations along (Forest Park Parkway and Millbrook Boulevard), the critical issue will be vehicular traffic turning across the tracks.
   c. Public awareness program needs to be planned prior to MetroLink operation, including training of police and fire department personnel to coordinate safety and enforcement programs of MetroLink.
   d. Special education period during initial start-up time will require traffic control personnel in selected locations, and special delineation devices may be required.
   e. Local agencies in coordination with BSDA must maintain commitment to comprehensive enforcement, without relaxation, including:
      - Consistent issuance of citations
      - Speedy and strict adjudication process
      - Use of towing vehicles

Specific Traffic Management Features

Along with the policies, the specific features of traffic management are described in the following paragraphs. These are organized to describe street geometrics, traffic operations, traffic controls, and access management.

1. Street Geometrics and Traffic Operations

   As noted at the beginning of this chapter, at-grade MetroLink operations would occur in three sections of the Cross-County corridor.

a. Forest Park Parkway/Millbrook Boulevard from the Forest Park MetroLink station through University City.
b. Downtown Clayton
c. South end of corridor in Maplewood along Laclede Station road and at Big Bend Boulevard/Oxford Avenue.

Geometric designs and traffic operations for each of these sections would be as follows:

⊙ Forest Park Parkway and Millbrook Boulevard.

- For this section, two at-grade design options will be considered. One would locate MetroLink tracks in the median of these arterial streets; the second would locate tracks at the south edge of the roadway. This latter location is also called a "side-running" alignment with tracks located parallel to Forest Park Parkway/Millbrook Boulevard.

- Forest Park Parkway and Millbrook Boulevard are four lane roads with supplemental turn lanes. Existing right-of-way of Forest Park Parkway and Millbrook Boulevard (west of Big Bend) is 90 feet. The two way track zone will be accommodated in this right-of-way while maintaining roadway cross-section in terms of the number of thru traffic lanes. Additional right-of-way will be necessary along Millbrook Boulevard, between Skinker and Big Bend where right of way is 80 to 90 feet, to accommodate the basic cross section; and at the MetroLink stations at Skinker Boulevard and Big Bend Boulevard to accommodate platforms and turning lanes.

- For MetroLink in the median location, a split platform concept will be used for the stations at Skinker Boulevard and Big Bend Boulevard. For the side-running option, a center platform will be positioned west of Skinker Boulevard. Because of the need to transition to an underground alignment west of Big Bend Boulevard and constraints associated with existing sanitary sewers in Millbrook Boulevard, the at-grade side-running option will transition into an underground alignment at a point east of Throop Drive. Hence, the Big Bend Boulevard station, for this alternative, will be underground, not at-grade.

  The use of the side platform concept for the median option provides a means to gain the most efficient use of right-of-way. The MetroLink platforms will be on the far side of each intersection. The approximate 10' wide space needed for the platform in the far side would line up with a left turn lane for general traffic in the approach or near side of the intersection. The left turn lane would not be on the tracks, but parallel to them

- At the Des Peres Avenue intersection, Forest Park Parkway would retain two lanes in each direction. For the tracks in the median option, left turn lanes on Forest Park Parkway would not be provided (no left turns to be allowed). Including left turn lanes would require changing track alignment by moving them 8 to 10 feet south of the center right-of-way position and would require 14 to 20 feet of additional right-of-way along the south edge of the existing roadway. For the side-running option, left turn on Forest Park Parkway would be included. These could be included into the existing 90' right-of-way. Des Peres Avenue would retain its existing geometry.

- At the Skinker Boulevard intersection, roadway geometrics would include two through lanes plus a left turn lane in all approaches. For the eastbound approach, a separate right turn would also be included in the MetroLink median option. There could be a need to add a second right turn lane. Traffic forecasts, expected later, will be used to verify the need for such added turning capacity. For the side-running (south edge) MetroLink option, the same basic geometrics will be provided. The need for separate right turn lanes in the eastbound approach will also be verified. In this side-running case, the space needs for right turn lanes is more difficult to accommodate since added lanes at this point requires the track alignment to be modified, i.e., move tracks further south and increase right of way acquisition needs.

- For the Skinker Boulevard intersection, an optional geometric concept involving a through lane underpass could be considered. This underpass would be placed in Skinker Boulevard and would provide one lane in each direction. These lanes would pass under Forest Park Parkway and the MetroLink tracks providing added traffic capacity for north-south traffic movement.

  The underpass structure would extend from the Lindell Boulevard intersection to at least Waterman Boulevard (possibly McPherson Avenue). In the southbound approach at Forest Park Parkway, the cross section would be adjusted to provide two southbound lanes (one for left turns, one for right-turns) and one northbound lane. In the northbound approach there would be two northbound lanes (one for left turns, one for right turns) and one southbound lane.

  Along the section containing the underpass structure, driveways and local intersections would be open, but they would be limited to right turn in/right turn out traffic movements.

- Along Millbrook Boulevard, existing intersections for Washington University campus at Hoyt Drive and Throop Drive would retain existing geometry including a westbound left turn lane at each location. This left turn lane requires the tracks to be realigned moving them 8 to 10 feet south of the center of right-of-way position. These turn lanes would not be on the tracks but parallel to them. Because of the need for added right of way along the south edge of Millbrook Boulevard, the position of the intersection approaches would be moved south to match the new south curb line of Millbrook Boulevard. This would be the case for either at-grade options.

- At Big Bend Boulevard, the median option will be the only at-grade alternative. Existing geometry would be retained, i.e., two thru lanes and a left turn lane in all approaches. The turn lanes on Millbrook Boulevard and space for platforms will require added right-of-way. The alignment of the tracks would be changed moving them 8 to 10 feet south of the center of right-of-way position. The turn lanes would not be on the tracks but parallel to them.

⊙ Downtown Clayton

- For this section, the at-grade alignment would cross Forsyth Boulevard at a point just west of Forest Park Parkway. The geometry of Forsyth Boulevard would be retained, but the access to the parking lot on the north side of the street would be relocated and modified.

- The alignment crosses Carondelet Plaza just south of Forsyth Boulevard and follows to north edge of Carondelet Plaza to a point east of Hanley Road where the alignment merges into the center of the street. Because of vertical grade coordination, Carondelet Plaza would be modified to either relocate its connection with Forsyth Boulevard to a point midway between Jackson and Lee Streets or to change its vertical elevation (by lowering) but maintain its connection to Jackson Street. The cross-section of Carondelet Plaza would be retained.

- At Hanley Road, MetroLink tracks would be located in the median (center) of the street. The Hanley Road cross-section would be retained. Two eastbound lanes would be provided for Carondelet Avenue in the intersection approach; and two westbound lanes in the Carondelet Plaza approach.

- Along Carondelet Avenue from Hanley Road to Central Avenue, one traffic lane in each direction plus an emergency stop space will be provided. This would exclude the existing curb parking lane. The cross-sections of Bemiston and Central Avenue would be retained.

Because of track elevations associated with the hill along Carondelet Avenue, MetroLink would be located in a barrier median in the block between Hanley Road and Bemiston Avenue. No mid-block vehicle or pedestrian crossings will be possible. Traffic circulation and access will need to use right turn-in and out movements. Possibly, some left turn access may be possible at the ends of the block. Left turn access to the Radisson Hotel may be retained depending on final details of ML track elevation. In the block between Bemiston and Central, the tracks will mostly match existing street elevation for the east half of the block (i.e., barrier median not required). In the west half of the block, the street elevation will be transitioning to match the lowered elevation in the Central Avenue intersection. There are no vehicle access points in this block, nor should there be in the future.

- At the Central Avenue intersection, vertical grade coordination with the MetroLink tracks and proposed station will require lowering the elevation of Central Avenue. This will cause some realignment of traffic lanes in the northbound, westbound, and southbound approaches.

- The block along Carondelet Avenue, between Central Avenue and Meramec, will be an "auto-free zone" or plaza. It would include the MetroLink tracks and station, but exclude other vehicle traffic.

- At the Carondelet Avenue/Meramec Avenue intersection, there are two design options, i.e., tracks continue west to Brentwood Boulevard or tracks curve south onto Meramec Avenue. For the former option, the cross-section of Meramec Avenue remains while Carondelet Avenue would have one lane in each direction excluding the curb parking lane. For the latter, the cross-section of Carondelet Avenue (to the west) remains while the Meramec Avenue cross-section would be modified. In the northbound approach, both MetroLink tracks would be swing along new right of way west of the existing street; there would be four traffic lanes, two in each direction.

- At the Carondelet Avenue and Brentwood Boulevard (for one option), the tracks would turn south along the west side of the street right of way. The curb parking lanes would be eliminated, but the same number of traffic lanes would be provided along Brentwood Boulevard, i.e., two lanes in each direction plus space for a left turn lane.

- Along Meramec Avenue at Bonhomme Avenue (for second design option), the tracks would occupy the west side of the street. The northbound approach to this intersection would have one lane northbound and two lanes southbound; the southbound approach would have two lanes in each direction. The Bonhomme Avenue cross-section would remain the same as existing.

⊙ CMT Right-of-Way

For different design alternatives, generally the CMT right-of-way, there could be additional at-grade MetroLink locations. Either of the following two locations could occur (i.e., one or the other or neither would be included in the preferred alternative): (1) Laclede Station Road between Flora Avenue and Sunnen Drive, and (2) Big Bend Boulevard and Oxford Avenue.

- The Laclede Station Road option would involve crossing both Flora Avenue and Sunnen Drive (access road serving the Sunnen Business Park) at-grade. In each case, the cross-section of these roads would not be changed by MetroLink. Flora Avenue has one lane in each direction and would be retained. Sunnen Drive currently exist only east of Laclede Station Road. It is proposed to extend west to Hanley Road. It is a four lane road and its cross-section would be retained.

- The Big Bend Boulevard/Oxford Avenue option involves at-grade crossing of Big Bend Boulevard at a point just north of the Oxford Boulevard intersection (i.e., access road into the Deer Creek Center) and of Oxford Avenue just east of Big Bend Boulevard. In each case, the existing cross-sections would be retained.

2. Traffic Controls

In coordination with the geometrics and operations, traffic controls would play a vital role in traffic management. Most of the control would be achieved via improvements in the traffic signal system and the implementation of a modified signal operational strategy.

Overview

There are three important aspects to the design and operation of traffic controls:

a. Operational strategies for at-grade MetroLink alignments crossing high volume arterial roads.
b. Facility requirements relative to need for crossing gates and railroad-type flashing red lights and system connection between traffic and MetroLink train control.
c. Traffic signal operational strategies employing pre-emption and/or prioritization concepts.

The national standards, cited previously, provide guidance relative to these topics and are highlighted in the following discussion.

- Operational Strategies

  Existing light rail transit experience across the United States indicates that at-grade operations in high volume highways is feasible. In central Baltimore, Maryland; San Jose, California; San Diego, California ; and Dallas, Texas to name a few locations, light rail transit operates at-grade crossing arterial roads with volumes in the 20,000 to 50,000 vehicles per day range[21]. Traffic control systems have been improving to provide the management means to accommodate such conditions in an efficient and safe manner.

  This issue was addressed by a special Institute of Transportation Engineers technical committee (#6A-42)[24]. Their results indicated that at-grade operational feasibility is a function of both highway volume (peak volume per hour per lane) and transit volume (trains per hour). For the range of MetroLink train volumes being considered for this Cross-County extension (6 to 8 trains per hour), the corresponding range in traffic volumes for feasible operation would be up to 900 vehicles per hour per lane[22].

  Further, if some delay to train operations (i.e., train occasionally being stopped at intersections) was acceptable, the traffic volume level for feasible operation could be extended to 1200 vehicles per hour per lane. As shown by Table 4, traffic volumes in the corridor are now and will likely be within this range or lower.

  Further, these guidelines specifically cite that detailed analyses for each location would be needed to verify operational feasibility. Such analyses has been undertaken for this operations plan and will be discussed later.

- Facility Requirements

  Beyond standard traffic signal facilities (signals, lights, controllers, and detectors), at-grade MetroLink alternatives require consideration of additional facilities:

  a. Need for railroad crossing protection in the form of gates and flashing warning lights/bells.
  b. Train presence detectors and communications between traffic and train control systems.

  With regard to the first topic, the matter needs to consider the difference between

---

[21] Blossom Hill Road @ 50,000 veh/day, Montague Expressway up to 70,000 veh/day -San Jose, CA
Howard Street and MLK Boulevard @ 30,000 to 40,000 veh/day -Baltimore, MD
U.S. Naval Base Main Entrance @ 30,000 veh/day -San Diego, CA

[22] ITE Journal, Jan. 1993 - “LRT Transit Grade Separation Guidelines - Figure 1"

railroad and light rail transit operations. There is typically a significant difference in the volume of train traffic, i.e., transit being significantly more frequent than railroad operations (freight or passenger trains).

There is also a significant difference in the clearance time for transit vs. railroad trains. MetroLink will cross through at-grade intersections in 15 seconds or less. Obviously, railroad trains can take substantially longer from 5 to 10 minutes (or more).

The vehicle performance characteristics are also significantly different. MetroLink trains have much shorter stopping distances (from normal running speed to stop) than railroad trains. They also have greater acceleration capability than trains.

These differences allow transit to function in an at-grade mode through intersections under traffic signal controls (no gates). This is true for the most urban areas having light rail transit. Federal Highway Administration standards[23] acknowledge these differences.

The use of traffic signal only control has become an accepted practice for light rail transit alignments that are located in the pavement or median of intersecting streets. This, however, is not the case for transit alignments that have a "side-running' position, i.e., they do not literally cross through the intersection but are closely parallel to one of the intersecting streets. The latter would be the circumstance for the south edge at-grade option along Forest Park Parkway and Millbrook Boulevard.

The issue for "side-running" tracks is that vehicle traffic could become trapped while standing across the tracks. With tracks crossing a street close to an intersection (within 200 feet according to most standards), vehicles on the cross street could queue across the tracks due to high traffic volumes or be waiting to make a turn. The cross street green light could change to red and these vehicles would still be stopped in the track zone. If a train were to arrive, these vehicles couldn't pull forward because of traffic flowing on the other street across their path. Hence, they would be trapped in a hazardous position.

For this reason, crossing gates and warning signals along with pre-emptive signal operations are deemed advisable. The gates prevent encroachment in the track zone while the signal operations provide time for traffic to clear. Such pre-emption could be implemented without crossing gates for roads with high volumes and frequent train crossings, reliance on signals alone would add risk.

This clearance/entrapment problem does not occur with tracks located in the intersection. When signals change, vehicles will clear the intersection and not stay in

[23] Railroad - Highway Grade Crossing Handbook.

the middle of the intersection.

The conclusion for MetroLink is that for the south edge (side-running) option, crossing gates and signals should be deployed at intersections including Des Peres Avenue, Skinker Boulevard, and Hoyt Drive.

For at-grade crossings not at intersections, gates and signals would be the standard to use. This would involve crossings of Forsyth Boulevard, Carondelet Plaza, Flora Avenue, Sunnen Drive, Big Bend Boulevard, and Oxford Avenue.

The second special facility need concerns train presence detectors and traffic/train communications. National practice, as reflected via ITE technical committees, provides input.

Traffic signals would be designed and installed consistent with the Manual on Uniform Traffic Control Devices (MUTCD). However, there are other signals to be included that would be used by MetroLink operators only. Sample transit signal aspects are shown on Figure 4. These would be installed along the tracks (between the tracks) to be clearly seen by operators. Typically, these signals use white light only, and would not be confused by motorists as controlling traffic movements.

As MetroLink operates in streets, at-grade, it needs to be detected in advance of intersections so that traffic signals can commence a special phasing sequence. Detectors would be installed along the tracks approaching intersections. At least two detector positions would be needed. The first one to be activated would communicate to the traffic signal controller that a train was approaching. This would trigger pre-programmed signal phases. A second detector would be located closer to the intersection, this would be connected to a train signal in the trackway telling the train operator that a green/go light will be available at the intersection or that the operator should be prepared to stop. The latter situation only occurs if other than full signal pre-emption is being used or if an emergency/malfunction has occurred.

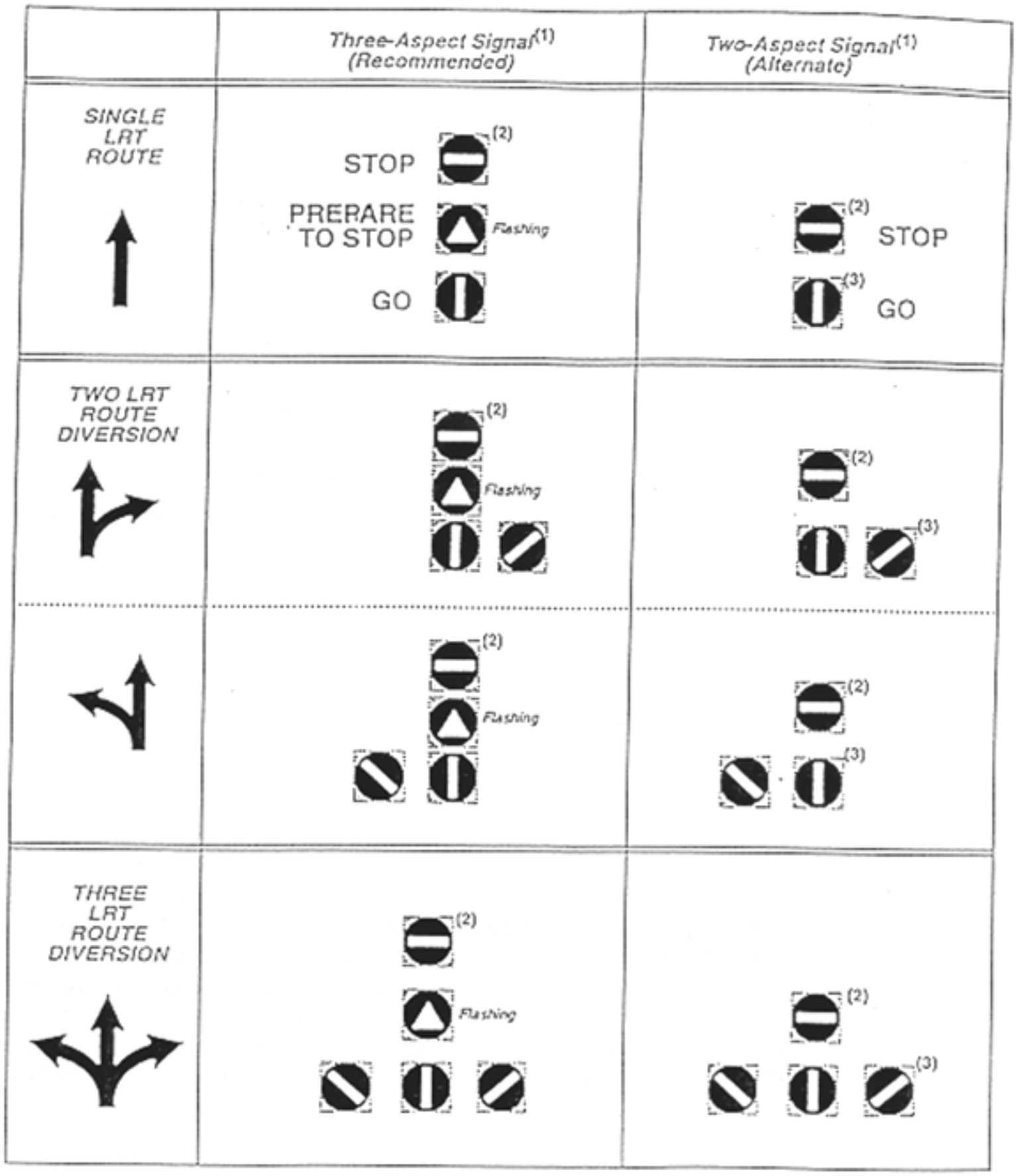
These special facilities - signals, detectors, and traffic/transit control communication linkages - would be necessary parts of the overall installation to assure proper at-grade operation. These would apply to any at-grade alignment option.

- Traffic Signalization Concepts

There are two basic strategies for operating signals including transit operations:

- Pre-emption in which traffic signals switch to red allowing undelayed passage of MetroLink through an intersection or across a road.

- Prioritization in which traffic signals switch to phases allowing undelayed passage, if possible, in coordination with other signal phases used at a given intersection.



Notes:
All Aspects are White.
(1) Could be in Single Housing.
(2) "Stop" aspect may be used in flashing mode to indicate "Prepare to Go".
(3) "Go" aspect used in flashing mode to indicate "Prepare to Stop".

Source:
MUTCD Hwy./Railroad Technical Committee
Proposed LRT Chapter changes, Oct. 1995

Figure 4
LRT SIGNAL ASPECTS

Most practice, previously used for railroad crossing control, has employed pre-emption[24]. This would be the case whenever crossing gates and flashing signals are used.

Using a typical pre-emptive operation, the train presence detector (20 seconds in advance of the intersection) activates the clearance phase in which all signals go red (green signals go to yellow then red). If gates are present, these and the flashing warning lights are activated at this time. Also No Left Turn and No Right Turn signs are illuminated for the street parallel to the tracks. If the tracks have a "side-running" position, there is a need to allow vehicles in the track zone to clear into and through the intersection. Such a clearance phase would require 10 to 15 seconds after which the signals for the street crossing the tracks would go red. Subsequently, signals for the street in parallel with the tracks would go green, except for the no left and right turn signs, which would continue to be illuminated.

MetroLink trains would require 10 to 15 seconds to cross a road. After which, the sequence to raise the gates and terminate warning lights would begin. The controller could be programmed to continue to green phase for the parallel street within some time limit (i.e., maximum amount of time for green phase); or it could immediately turn yellow then red. The latter option could be connected to presence detectors on the street crossed by the tracks. These detectors could identify the presence of an extensive queue of vehicles created by the closed crossing gates. As a priority, the controller would be programmed to provide a green light to the cross street as soon as possible to allow traffic conditions to "recover" back to normal (i.e., reduce the queue).

The time for clearance phases (both vehicles and MetroLink) would add up to 25 to 35 seconds. This time would be in effect, subtracted, in part, from possible green time for the street crossed by the tracks. With traffic signals in the corridor using 100 second cycle lengths, these clearance phases represent 25 to 35% of the cycle time. Depending on when the train arrives, such pre-emption could eliminate most of the available green time for the cross street in a signal cycle. With MetroLink trains operating at 8 minute headways, trains from either direction would pass a cross street every four minutes (240 seconds) or every 2½ signaled cycles. The cross street could end up having a green light during only one of each three signal cycles. For cross streets with high traffic volumes, this would create significant delay potential.

[24] ITE Technical Committee #4M-35 - "Pre-emption of Traffic Signals at or near actively protected railroad crossings" November 1994.

This impact of pre-emption operations gives rise to prioritization strategies. As noted by operational studies[25] conducted for the San Jose, CA and Dallas, TX light rail systems, these strategies achieve optimization of signal operations to provide for light rail transit movement, but without imposing unreasonable delay on other traffic.

The use of prioritization, however, applies to those situations where transit tracks are in the intersection. For MetroLink options, prioritization would be well-suited for the median alignment option; but would not include the "side-running" alignments.

Prioritization entails the insertion of a transit signal phase at an optimum time, i.e., when the green light would normally be activated for the street in parallel with the transit tracks. In this way, the signal cycle time allocated to the parallel street is concurrently used by transit. Traffic phases are not reduced and capacity is maintained for traffic flow.

The coordination, time-wise, is the key consideration. If train movements were absolutely predictable (to the second), MetroLink phases could be scheduled for all at-grade intersections in the most optimal fashion (i.e., with parallel street green). However, such predictability is not reality. MetroLink trains will follow a schedule with reasonable adherence, but the precise arrival and departure of trains is subject to various uncontrolled conditions (e.g., time it takes for passengers to board, volume of people, operating conditions along the entire MetroLink system). Because of this situation, the train detectors, linked to the traffic controller, provide a means to estimate MetroLink arrival at a given intersection. With this information, the controller would be programmed to adjust the signal phasing to either advance or extend a green signal phase for MetroLink to use. This would be done within certain prescribed limits (i.e., available windows of time in the overall signal cycle within which such adjustments could be made).

---

[25] Traffic Signal and Track Warning Device Timing Relationships at the Greenville and Blackwell Intersection for DART's LRT crossing, Barton-Aschman, November 1996, Technical Memo.

Light Rail Impacts on Surface Street Operation in Santa Clara County, by Jon Elison and Chas. Felix, 1991 ITE Compendium of Papers.

Integration of Light Rail Operations and Roadway Traffic Control - The Dallas Area Rapid Transit System Approach, by Dave Carter, 1994 ITE Compendium of Papers.

Depending upon when MetroLink trains arrive at an intersection like Skinker Boulevard, trains may be able to proceed through or be stopped. One strategy to mitigate transit delay at traffic signals would be to employ a dispatching function at the Forest Park and Carondelet Avenue/Meramec MetroLink stations. The former would be used for westbound trains and the latter for eastbound trains. In this manner, MetroLink would be held at these stations and dispatched at the proper time to coincide with green signal phases at key intersections along the route, i.e., Skinker Boulevard/Forest Park Parkway, Big Bend Boulevard/Millbrook Boulevard, and Carondelet/Hanley Road. Dispatching would enhance the capability to predict train arrival at intersections in a more predictable fashion.

- Specific Traffic Control Devices[26]

  - Traffic signals exist at the following intersections along the route:

    - Des Peres Avenue at Forest Park Parkway
    - Skinker Boulevard at Forest Park Parkway
    - Big Bend Boulevard at Millbrook Boulevard
    - Hanley Road at Carondelet Avenue
    - Bonhomme Avenue at Meramec Avenue
    - Hoyt Drive at Millbrook Boulevard
    - Throop Drive at Millbrook Boulevard
    - Pedestrian crossing signals at two locations along Millbrook Boulevard: west of Big Bend Boulevard (about 800') and midway between Throop Drive and Hoyt Drive.
    - Big Bend Boulevard/Oxford Boulevard - Oxford Avenue

  - New traffic signals would be added at the following intersections:

    - Carondelet Avenue at Bemiston
    - Carondelet Avenue at Central
    - Carondelet Avenue at Meramec
    - Carondelet Avenue at Brentwood Boulevard (for one option)

  - Traffic signal phasing

[26] LRT intersection traffic control devices require permits from the Division of Motor Carrier and Rail Safety, Department of Economic Development, State of Missouri.

Traffic signal operations will employ both prioritization and pre-emption concepts. The former would be used along Forest Park Parkway and Millbrook Boulevard for the median alignment option and to all intersections in downtown Clayton. The latter (pre-emption) would be used along Forest Park Parkway and Millbrook Boulevard for the south edge (side-running) alignment option.

For prioritization operations, signal phasing sequences would be as follows:

a. Traffic Signal Phase Sequence

The signal phase sequence is the type and order of the traffic signal phases as they are called (illuminated by signal light). The phasing sequence for MetroLink signals varies by location. The first difference is between concurrent and non-current intersections. Concurrent intersections are where MetroLink can move with parallel traffic. This occurs where there are no turning movements allowed across the tracks, or, if turning movements are allowed across the tracks with a separate turn lane that can be controlled by separate signal phase; permissive left turns would not be allowed.

Non-concurrent intersection are where MetroLink tracks turn from one street to another requiring a separate transit phase and all other traffic must stop. At non-concurrent intersections, other traffic loses a significant amount of green time because of the LRT only phases. This lost time was applied during the capacity analysis with a special feature called pedestrian phase time. The specification of pedestrian phase provides all red to the autos in each cycle.

Figure 5 lists the different signal phase sequences that apply to all of the corridor MetroLink intersections[27]. This diagram is drawn with north at the top of the page. For each row in the chart, the travel signal sequence would proceed from left to right. The arrows indicate which movement has a green signal. The MetroLink track symbol indicates when trains move. The transit phases will be called as needed. Limitations in the available time in the cycle length may postpone processing a call until the next cycle.

[27] Turning at the intersection of Carondelet/Brentwood (Option B) is an alternate to turning at the intersection of Carondelet/Meramec (Option A).

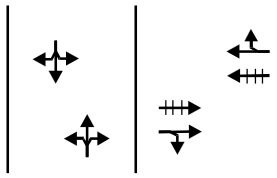
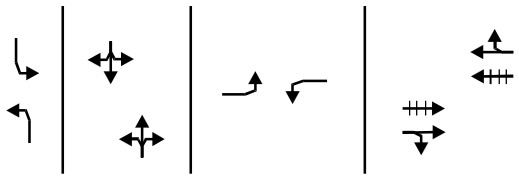
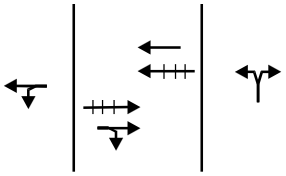
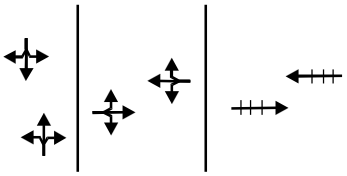
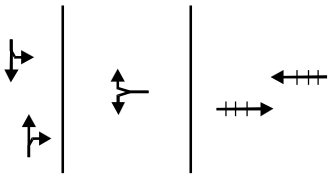
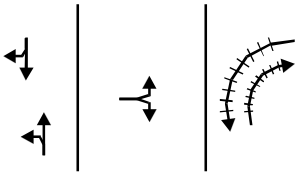
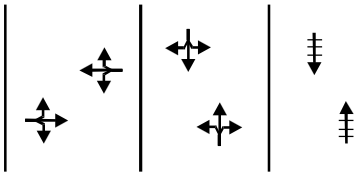
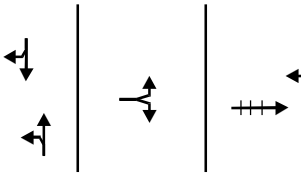
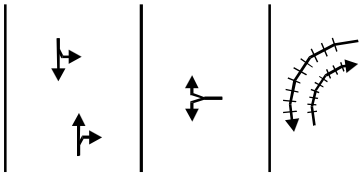
Sequence	Intersection
	Des Peres @ Forest Park
	Big Bend @ Millbrook Skinker @ Forest Park Hanley / Carondelet (train straight-thru)
	Hoyt @ Forest Park Throop @ Forest Park
	Carondelet / Bemiston
	Carondelet / Central (Pedestrian-Transit Mall on West Approach)
 OPTION A Carondelet / Meramec (train turning 90˚) (Pedestrian-Transit Mall on East Approach) 	Meramec / Bonhomme
 OPTION B Carondelet / Meramec (Pedestrian-Transit Mall on East Approach) 	Carondelet / Brentwood (train turning 90˚)

Figure 5
PROPOSED TRAFFIC SEQUENCING

b. Cycle Lengths

The cycle length is the amount of time that is required to process the entire signal phase sequence. The length of the signal cycle is determined by the sum of the required individual phase lengths. Limitations exist on the maximum cycle length due to the amount of time vehicles and autos must wait during a red phase and corresponding length of queues. In the core of downtown Clayton, the pedestrian stop or waiting time is most important. Pedestrians tend to have a limited tolerance for waiting, no more than about 30 seconds. Phases need to be organized to allow pedestrian to move within this interval of time.

The standard cycle length for intersections with MetroLink operations will be 100 seconds along Forest Park Parkway/Millbrook Boulevard and 72 and 80 seconds in downtown Clayton. There are existing closed-loop signal systems in the corridor that may operate on a longer cycle. These exist along Forest Park Parkway - Millbrook Boulevard and are being enhanced along Skinker Boulevard. Such operations would be coordinated with this phasing.

c. Phase Lengths

The duration of each signal phase is based on the amount of time required to accommodate traffic movement subject to minimum time required for yellow signal and pedestrian clearances. The minimum time required for each through auto phase is the time necessary to allow pedestrians to walk across the stopped street in the intersection. This time is calculated by providing a minimum walk time of seven seconds plus a don't walk time equal to the time necessary for a pedestrian to clear the intersection at an average walking speed of four feet per second.

d. MetroLink Clearance Timings

The phase length for a MetroLink phase is determined by the amount of time required to clear a train through the intersection. This is determined based upon three factors:

- The travel speed of the train.
- The length of the train
- The distance through the intersection

The maximum travel speed of MetroLink is the legal speed limit (35 to 45 mph along Forest Park Parkway and Millbrook Boulevard, and 25 mph in downtown Clayton). MetroLink traveling through an intersection should maintain this speed unless it is slowing for a station. A train turning through an intersection will be required to slow down considerably in cases of varying track geometry.

Along Forest Park Parkway - Millbrook Boulevard, there are proposed stations at Skinker Boulevard and Big Bend Boulevard. Trains approaching these intersections will always be slowing down to stop. Within downtown Clayton, MetroLink trains will operate at slow speed throughout the at-grade section.

e. Integration of Traffic Signal and Train Control Systems

As the preceding indicated, the traffic signal controls would be managed via local controllers. There would be closed-loop traffic signal system operations along Forest Park Parkway - Millbrook Boulevard and Skinker Boulevard that would be part of the controller-to controller communications.

There is a need to connect the MetroLink control/communications system with traffic control. This would be in the form of status information to identify the signal status at anytime. Further, train detectors would be placed in advance of traffic signal locations in order to trigger signal phasing sequences. This would include either extending the parallel (train) green phase or advancing the beginning of the parallel green phase. Such modifications would fit into a background cycle in which the traffic signal operates. Given the distance (and time) the train is from the signal, the controller will determine if the adjustment can be made.

At a point in advance of the signal represented by the LRT train safe stopping distance, the communication system will identify if a green phase will be provided. If not the operator will brake the train for safe stopping.

f. Pre-emption Phasing

The discussion, earlier in this chapter, addressed the prioritization concept for signal operation. This will affect the majority of the signalized intersections. However, pre-emption phasing would also be applied to the Des Peres Avenue, Skinker Boulevard and Hoyt Drive intersections, as part of the south edge (side-running) alignment option along Forest Park Parkway and Millbrook Boulevard.

The basic aspects of pre-emption were discussed in previous sections. In contrast to the phases shown on Figure 5 for Skinker/Millbrook and Hoyt/Millbrook under a prioritization concept, the phase sequence for pre-emption would be:

- Skinker Boulevard

1. Crossing gates and flashing signals activated with all signals to red (current green to yellow first) except for the northbound intersection signal on Skinker which would become green to clear the track zone.
2. Train crossing phase with Forest Park Parkway/Millbrook Boulevard through movement (eastbound and westbound) green.
3. Train clears and activates the release of the gates and termination of flashing and warning lights.
4. Skinker left turn phase to green (both directions)
5. Skinker thru movements.
6. Forest Park Parkway/Millbrook Boulevard left turn phases.
7. Forest Park Parkway/Millbrook Boulevard through movements.

- Des Peres Avenue and Hoyt Drive

  Follows the same sequence as described for Skinker Boulevard.

g. Traffic level of service

To indicate, in a preliminary fashion, the impact of the proposed prioritization signal phasing, traffic level of service analysis[28] was completed for the intersections in the Forest Park Parkway-Millbrook Boulevard and downtown Clayton sections. The analysis will be modified later in the project to more specifically reflect proposed street geometry associated with the conceptual designs. These results are summarized by Tables 5 & 6. Detailed computation sheets are included in the Appendix.

Tables 5 and 6 provide information about traffic conditions with and without the passage of MetroLink trains. These tables are organized as follows:

- Existing Conditions Columns - describes conditions without the presence of MetroLink.
- Train w/ Traffic Green Columns - describes conditions in which MetroLink trains would be present; trains would be accommodated only during the green signal for the street in parallel with the tracks (i.e., Forest Park Parkway, Millbrook Boulevard, or Carondelet Avenue).
- No Train Columns - describes conditions at intersections which do not have separate left turn signal phases on streets parallel to the tracks; these columns indicate conditions without train presence.
- Full Train Clearance Columns - describe conditions wherein a separate signal phase is provided for MetroLink with no other traffic movement.
- Weighted Average Columns - assumes trains pass through the intersection each 4 minutes (considering both directions) during a typical hour, shows average delays for signal phases with and without train signal phases.

[28] Using Signal 94, a software which translates the Highway Capacity Manual.

TABLE 5
Cross County MetroLink Extension
Capacity Analysis Results
AM Peak Hour

Corridor Intersection	Cycle Length	Existing Conditions		Average Clearance		No Train Clearance		Full Clearance Time		Weighted Average	
		LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Forest Park/Millbrook											
DeBaliviere	100	C	19.7	NA	NA	NA	NA	NA	NA	NA	NA
Des Peres (1)	100	B	11.5	B	14.6	NA	NA	NA	NA	NA	NA
Skinker (1)	100	D	25.5	D	26.7	NA	NA	NA	NA	NA	NA
Skinker (2)	100	D	25.5	C	17.0	NA	NA	NA	NA	NA	NA
Hoyt (1)	100	B	7.1	B	10.0	NA	NA	NA	NA	NA	NA
Throop (1)	100	A	2.6	A	4.8	NA	NA	NA	NA	NA	NA
Big Bend (1)	100	D	26.3	D	29.2	NA	NA	NA	NA	NA	NA
Big Bend (2)	100	D	26.3	C	16.0	NA	NA	NA	NA	NA	NA
Carondelet											
Hanley (1)	120	C	17.1	C	19.9	NA	NA	NA	NA	NA	NA
Bemiston (1) *	72	B	5.4	NA	NA	B	9.8	B	14.7	B	11.3
Central (3) *	72	A	4.3	NA	NA	B	10.5	B	13.5	B	11.4
Meramec (4) *	72	A	2.1	NA	NA	B	9.0	B	13.5	B	10.4
Meramec											
Bonhomme (1)	72	B	10.0	NA	NA	B	10.0	B	12.5	B	10.8
Shaw Park	72	B	5.1	NA	NA	NA	NA	NA	NA	NA	NA

(1) Taking median-running through trains into consideration.
(2) Taking median-running through trains into consideration and northbound/southbound thru movement grade-separated.
(3) Taking through trains into consideration and west approach closed to vehicular traffic.
(4) Taking turning trains into consideration and east approach closed to vehicular traffic.

* Existing intersection is unsignalized.

**Weighted Average Delay = [(Delay with full clearance time * Number of cycles with "LRT only" phase) +
(Delay with no clearance time * Number of cycles without "LRT only" phase)] / [Total number of cycles]
Based on 8 minute train headways.

TABLE 6
Cross County MetroLink Extension
Capacity Analysis Results
PM Peak Hour

Corridor Intersection	Cycle Length	Existing Conditions		Average Clearance		No Train Clearance		Full Clearance Time		Weighted Average**	
		LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
Forest Park/Millbrook											
DeBaliviere	100	C	25.0	NA	NA	NA	NA	NA	NA	NA	NA
Des Peres (1)	100	B	9.4	B	12.8	NA	NA	NA	NA	NA	NA
Skinker (1)	100	D	27.1	D	30.5	NA	NA	NA	NA	NA	NA
Skinker (2)	100	D	27.1	C	17.6	NA	NA	NA	NA	NA	NA
Hoyt (1)	100	B	8.7	B	12.6	NA	NA	NA	NA	NA	NA
Throop (1)	100	A	5.5	A	7.9	NA	NA	NA	NA	NA	NA
Big Bend (1)	100	D	30.3	D	32.9	NA	NA	NA	NA	NA	NA
Big Bend (2)	100	D	30.3	C	16.2	NA	NA	NA	NA	NA	NA
Carondelet											
Hanley (1)	120	C	16.7	C	23.5	NA	NA	NA	NA	NA	NA
Bemiston (1) *	72	B	5.9	NA	NA	B	10.1	B	14.9	B	11.5
Central (3) *	72	A	3.9	NA	NA	B	8.8	B	12.0	B	9.8
Meramec (4) *	72	A	3.4	NA	NA	B	9.7	B	14.2	B	11.1
Meramec											
Bonhomme (1)	72	B	12.4	NA	NA	B	12.4	B	12.4	B	12.4
Shaw Park	72	B	8.0	NA	NA	NA	NA	NA	NA	NA	NA

(1) Taking median-running through trains into consideration.
(2) Taking median-running through trains into consideration and northbound/southbound thru movement grade-separated.
(3) Taking through trains into consideration and west approach closed to traffic.
(4) Taking turning trains into consideration and east approach closed to traffic.

* Existing intersection is unsignalized.

**Weighted Average Delay = [(Delay with full clearance time * Number of cycles with "LRT only" phase) +
(Delay with no clearance time * Number of cycles without "LRT only" phase)] / [Total number of cycles]
Based on 8 minute train headways.

This analysis will be redone later in the project when future traffic volume estimates are available. These volumes would reflect potential traffic growth, shift in mode use due to the MetroLink extension, and some shift in traffic patterns due to changes in access. The latter would occur mostly in downtown Clayton due to changes in access along Carondelet Avenue, between Hanley Road and Bemiston. Access would become right turn in and out only. This will cause a change in traffic patterns at the Hanley Road/Carondelet Avenue intersection and at other locations. At Hanley Road, it would be expected that the northbound left turn in the A.M. peak and eastbound flow would decrease significantly. This would be balanced by some increase in traffic through the Carondelet Avenue/Bemiston Avenue intersection. Such changes will be examined later as part of impact analysis.

The detailed level of service analysis has not been applied to the pre-emption signal concept. As discussed earlier, pre-emption would add significant delay to the north-south streets crossed by MetroLink. This would affect Des Peres Avenue, Skinker Boulevard, and Hoyt Drive. It would be expected that for Skinker Boulevard, delay could increase by 10 to 15 seconds. Level of service would become E. If this lower level of service is verified, via further analysis, and is considered unacceptable, some change in signal operation would be necessary. This could require use of prioritization signal phasing rather than pre-emption. In this way, some delay for MetroLink trains would be introduced in order to reduce delay for Skinker Boulevard. For Des Peres Avenue and Hoyt Drive, the impact would be insignificant because of the low volumes on Des Peres Avenue and Hoyt Drive.

- Other Crossing Control Devices

At other locations (than described in the preceding section), the intersecting roads and drives will be controlled by crossing gates and flashing red signals. At these locations, detectors will provide a minimum 20 second warning time.

It is anticipated that gates and red flashing signals will be provided at: The south edge (side-running) alignment along Forest Park Parkway and Millbrook,

at Des Peres Avenue (south approach)
at Skinker Boulevard (south approach)
at Hoyt Drive (south approach)

Forsyth Boulevard at west of Forest Park Parkway
Carondelet Plaza, south of Forsyth Boulevard
Carondelet Plaza, east of Hanley Road
Flora Avenue, west of Laclede Station Road
Sunnen Drive at Laclede Station Road
Big Bend Boulevard north of Oxford Boulevard
Oxford Avenue, east of Big Bend Boulevard.

For all of the above locations, traffic signals and gates/warning signals will operate in the pre-emption mode, as explained previously; the exceptions will be the Forsyth Boulevard, the two Carondelet Plaza locations, Flora Avenue, and Sunnen Drive. At these five locations, these will be only crossing gates and flashing signals without any traffic signals.

The Forsyth Boulevard crossing and Carondelet Plaza crossing just south at Forsyth Boulevard may entail special linkage to near by signals for the former, the close proximity to the signals at Forsyth/Bland Avenue plus site distance considerations associated with the Forsyth Boulevard alignment and Forest Park Parkway overpass structures indicates a potential need to link the crossing gate signal operations with the traffic signals. In operations there would be a clearance interval used with a red phase for westbound/eastbound movement being illuminated with time allowed for Forsyth Boulevard traffic to clear the track crossing. Train detectors communication with Forsyth/Bland controller, westbound vehicles on Forsyth are given enough time to clear the crossing before a red phase is illuminated at Bland Avenue. Similarity for the Carondelet Plaza crossing, the signals at Jackson/Forsyth or at the new Carondelet Plaza/Forsyth intersection would include a clearance phase so that traffic on Carondelet Plaza can clear the crossing.

- Pedestrian and Bikeway Movement

  An important element of traffic management concerns pedestrians and bike traffic. Pedestrian and bicyclists require a significant share of the potentially available public right-of-way. From a traffic management perspective, the elements for pedestrians and bikes would be as follows:

  - Traffic signal phasing will always incorporate sufficient pedestrian crossing time, that is, the time for persons to cross the street walking at a reasonable speed. This is critical for dense pedestrian zones, e.g., downtown Clayton, Washington University, and Forest Park.

  - Sidewalk widths must be sufficient to accommodate peak pedestrian volumes.

  - Pedestrian movements are to be managed so that they occur at intersection crosswalks. Measures, such as urban design treatment, would be instituted to prevent midblock crossing.

  - Bike access will be important in some locations. This will be true in areas close to residential neighborhoods. Similar to addressing pedestrian access, bike access is planned to maximize safety. Linkages to neighborhood bike routes (on-street or off-street) would be incorporated into station access designs.

- Truck Operations

  Access for goods delivery, service, and maintenance is needed by the various land-use activities in the corridor, especially in downtown Clayton. Access to alleys and loading docks would be maintained. Along Carondelet Avenue and Meramec Avenue, on-street loading space would be limited. The concept of time management can be applied for some of this demand. Using this concept, trucks would be able to use the track areas with authorization during the hours when MetroLink would not be in operation.

- Emergency Vehicle

  The corridor must continue to be accessible for emergency vehicles. Property cannot be land-locked, nor can any facilities be constructed to prevent appropriate access. Access along all public streets and alleys in the system will be maintained to allow for this contingency.

Land-Use Access

MetroLink will operate in a safer environment and be able to better maintain schedules when potential crossings of MetroLink tracks is limited. The following addresses the midblock access and the management strategies to be employed.

1. Midblock Access Policies

The issue concerns the need for property access, public safety and the disruption of MetroLink service. Turns across the tracks at midblock locations shall be prohibited where possible.

In the case of median or center of the street located tracks, where alternate vehicle access is available, crossing the tracks will be prohibited. The latter would utilize design features (e.g., barriers) and regulatory measures.

Alternate access could be provided via access to and from other streets or alleys is available; or where joint use of access with adjacent properties is feasible, then a single access shall be provided; or if multiple access drives for the same property exist, they shall be consolidated into a single access point.

Where access across MetroLink tracks must be allowed, one or more of the following access management strategies would be employed:

a. Basic Signage

   At all locations where driveways, alleys, or other passageways intersect MetroLink tracks, signs will be erected to direct the appropriate functioning of those intersections. In addition, the conditions outlined below would be implemented with appropriate signing as guided by MUTCD and local agencies standards.

b. Time Management

   Access will be allowed during non-operating hours wherever possible and by permit during operating hours when necessary.

c. Access Control

Active control measures will be employed where access conditions create a high potential for disruption to MetroLink operations. The purposes of the active control measures are to maintain the priority movement of the trains and prevent or limit interference with cross traffic. Active control measures are either traffic control or warning signals or access managers that control pedestrian flow and street traffic and manage queues. These conditions exist where there are relatively high-volume maneuvers (in excess of 20 vehicle per peak hour) across the tracks or there is a limited sight distance. When volumes are relatively low (less than 20 per peak hour), a passive control measure, such as a sign, will be used.

2. Access Management Actions

The following actions are recommended to manage midblock crossings along the sections of the corridor where at-grade MetroLink alignments would be considered.

Location	Existing Access	Modification
Forest Park Parkway-DeBaliviere to Skinker	(1) alley access on south curb line	• ML[29] in median-no change. • ML in south edge- no change.
Millbrook Boulevard-Skinker to Big Bend	(1) two right in/out driveways to campus parking and service access	• ML in median-access to be retained, road widening will cause modified geometrics for driveway. • ML in south edge-access allowed to cross tracks, stop sign controlled with flashing warning light when trains approach, major geometric change.
Big Bend to Pershing	(1) one commercial driveway north curb line	• ML in median-access to be retained, road widening will cause modified geometrics.

[29] ML - abbreviation for MetroLink.

Carondelet Plaza - Forsyth to Hanley	(1) alley access, both side near Hanley	• ML in north edge-access to be retained, some geometric change in north alley access.
Hanley to Bemiston	(1) north side - 5 driveways providing access to parking facilities.	• ML in median with barrier access to be retained but left turn in/out will be prohibited except for alley access just west of Hanley Road where left turns may be possible.
	(2) south side - 4 driveways, to parking service docks, and hotel front door drop-off	• Same comments as preceding; left turn access to Radisson Hotel may be retained depending on final details of ML track elevation.
Carondelet Avenue - Bemiston to Central	(1) no access	• ML in median-access possible including left turns if necessary; new site access should be encouraged to Central and/or Bemiston frontages.
Carondelet Avenue - Central to Meramec	(1) no access	• Block to be closed to vehicle traffic except for ML, emergency vehicle access retained.
Meramec Avenue - Carondelet to Bonhomme	(1) east side - 5 county parking garage access drives	• ML on west side of pavement-no change in access.
	(2) west side - one ally access	• ML on west side-alley access to be changed to one-way westbound with access controlled by gate and flashing warning lights; the option would be to close this access.

Meramec-Bonhomme to Shaw Park Drive	(1) east side-6 access drives and 1 alley access. (2) west side - one alley access.	• ML on west side-no change in access. • ML on west side-change to entrance only (one-way westbound) crossing of tracks, use warning signals and crossing gates; the option would be to close this access.
Carondelet Avenue - Meramec to Brentwood Boulevard	(1) north side - 2 driveways providing access to parking and alley (2) south side - 2 driveways providing access to parking and alley	• ML in median - access to be maintained including left turns. • Same as preceding comment.
Brentwood Boulevard - Carondelet to Shaw Park Drive	(1) west side - loop drive to park buildings	• ML on west side - access allowed controlled with stop sign with flashing warning signals at both entrance and exit, illuminated "NO RIGHT TURN" sign for entrance coordinated with traffic signal operation at Brentwood/Bonhomme.
	(2) east side - 2 driveways and one alley	• ML on west side - no change.
Big Bend Boulevard - north of Oxford Boulevard	(1) east side - 1 access to parking	• ML in CMT right-of-way will eliminate existing parking lot use of right-of-way.
Oxford Avenue - east of Big Bend Boulevard	(1) north side - 1 access	• Same comment as preceding.
	(2) south side - 2 access driveways	• No change in access except as coordinated with ML station access drives for the Deer Creek station.