CROSS-COUNTY MetroLink Extension

Segment 1
Conceptual Design

Cross-County
MetroLink
Extension

Candidate Design Alternatives
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

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Purpose

Previous activities in this study resulted in the identification of design concepts for the Cross-County Corridor Segment I Extension. A more limited set of design alternatives need to be selected from among the concepts. These design alternatives will then be carried forward into more detailed conceptual design with cost estimates and be evaluated in detail.

This technical paper describes a screening process whereby the various concepts have been reviewed and a set of design alternatives are recommended.

The discussion in this technical paper is based upon the information contained in two previous technical papers[1] and other data collected in the initial stages of this study. The latter includes right-of-way information, available traffic volume data (mostly average daily traffic counts for major streets), topographic surveys for Clayton downtown streets, and a utility system inventory.

Also, inasmuch as the recommendations contained in this report have been based upon information assembled to date, there is the possibility that additional data may indicate that the candidate alternatives could have significant constructability and/or operational problems. This could require some adjustment or modifications in the candidate alternatives as currently envisioned.

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[1]
- System and Alignment Design Concepts, Cross-County MetroLink Extension Segment I, prepared by the Parsons Transportation Group for the East-West Gateway Coordinating Council, 9/98.
- Forest Park Circulator Concepts, Cross-County MetroLink Extension Segment I, prepared by the Parsons Transportation Group for the East-West Gateway Coordinating Council, 9/98.

2
Screening Approach

By definition, this screening activity is a review and comparison of the identified design concepts for the MetroLink extension, using information available at this time. The comparison utilizes screening criteria (described later) to identify which concepts should be considered and carried forward as design alternatives into conceptual design.

Principles

The screening process, used to identify candidate design alternatives, has been guided by two primary principles.

1. Feasibility of construction and operation.

2. Representation of an appropriate range of rational choices in terms of performance, costs, impacts and benefits.

Applying these principles leads to candidate alternatives that have a reasonable potential to be built and achieve appropriate performance. They would also represent a range of possibilities in which concepts could be combined in unique ways to form a preferred design for the Segment I extension. This approach will also produce a corresponding range in cost estimates. The latter component will be essential in order to develop a financial strategy for this transit improvement project.

Screening Criteria

In order to consider feasibility of construction and operations for the identified concepts (per the System and Alignment Concepts report results), the following screening criteria are recommended:

1. Constructability

    a. Potential right-of-way or space within existing public right-of-way to accommodate MetroLink.
    b. Attributes of potential right-of-way to permit reasonable (according to typical design standards and policies) horizontal and vertical alignment.

2. Operations

    a. Transit accessibility in terms of relationship of potential MetroLink station locations to the possible pattern of person trips (origin and destination locations).
    b. Potential speed or travel times for MetroLink in relation to alignment.
    c. Street traffic management in terms of potential to accommodate LRT tracks in public streets and retain traffic lanes and land-use access.

3. Land-Use Displacement

    This criterion is associated with the potential need for new right-of-way to accommodate MetroLink. This could be either an expansion of an existing public right-of-way or creation of a new right-of-way. Displacement would be identified in terms of the potential for residential units, commercial or industrial buildings to be acquired.

4. Potential for MetroLink Extension

    This criterion is associated with the continued future expansion of the MetroLink system. Alternatives need to consider the potential for extending MetroLink via the Segment II and III projects in the Cross-County Corridor plus possible transit extensions in the west corridor.

Range of Choices

The previously identified concepts represent a range in choices relative to horizontal location and vertical alignment. The former entails various street locations while the latter concerns application of five different vertical alignment concepts (elevated, at-grade, underground-open cut, underground-cut and cover, or underground-bored tunnel). The combination of horizontal and vertical alignment creates a range of difference in terms of performance, costs, benefits, impacts and benefits. Candidate design alternatives should reflect such possible combinations.

3
Concept Screening

The results of the screening approach are summarized in this chapter. As an introduction, the design concepts under consideration are briefly described.

Design Concepts

Highlights of the various concepts under consideration are as follows:

Forest Park Station through University City

1. Horizontal location involves use of Forest Park Parkway and Millbrook Boulevard. MetroLink facilities are located at one or more positions within these streets.

2. Two vertical alignment options are possible for the central sections of this area - below ground or at surface. Below ground involves combinations of open cut and cover concepts. Below ground/cut and cover is the only option for the east and west ends of this area, i.e.:

    a. East end - connection to existing MetroLink tracks occurs at a point east of DeBaliviere Avenue; extension to west along Forest Park Parkway is below ground/cut and cover at least to some point west of DeBaliviere Avenue.

    b. West end - at the point where Millbrook Boulevard meets Forest Park Parkway (near the Pershing Avenue - Wellesley Avenue intersection) and to the west along Forest Park Parkway to the east edge of Clayton (near Forsyth Boulevard), the line is below ground/cut and cover.

Clayton and the Galleria Area

1. For the section through the Clayton Central Business District, the location options include one of three possible streets (Forsyth, Carondelet, Bonhomme) that pass through the core or the use of Forest Park Parkway/Shaw Park Drive at the south edge of downtown. As an option to extending west to Brentwood Boulevard, Meramec Avenue is a possible alternate linking Forsyth, Carondelet, and Bonhomme to Forest Park Parkway via an at-grade or below grade concept. For the core streets, the vertical alignment concepts are below ground or at surface. For Forest Park Parkway/Shaw Park Drive, the concept is an elevated transit alignment.

2. For the section from the west edge of the downtown south to the Galleria area, the alignments transition from being in the public street right-of-way to the Citizens for Modern Transit (CMT) right-of-way (previous Terminal Railroad right-of-way). The options for linkage to the CMT right-of-way are (1) via Brentwood Boulevard to the south from the downtown west edge (at Forsyth, Carondelet, Bonhomme) (2) Forest Park Parkway/Shaw Park Drive, or (3) west via Maryland Avenue to the CMT right-of-way just east of the Ladue Road/I-170 interchange. For the Brentwood Boulevard or Maryland Avenue routes, both below ground and at-surface concepts are considered. Also, the Brentwood Boulevard route accesses the CMT right-of-way north of Clayton Road or at Galleria Parkway.

3. For the section near the Galleria, the alignment is either on the CMT right-of-way or in the Brentwood Boulevard corridor. There are three choices for the latter:

    a. Below ground,
    b. At surface along Brentwood Boulevard and Galleria Parkway to the CMT right-of-way,
    c. via an elevated structure in a new right-of-way or easement parallel to the east edge of Brentwood Boulevard and the Galleria Parkway over I-170 to the CMT right-of-way.

Richmond Heights to Shrewsbury Area

For this area, there is one basic alignment along the CMT right-of-way. Tracks are on the surface to Flora Avenue. South of Flora, there are alternative design options. For the Sunnen Business Park section (Flora Avenue to Big Bend Boulevard), the alignment is elevated or below ground/cut and cover. The section from Big Bend Boulevard to Shrewsbury (Lansdowne Avenue), is elevated. There are two or more horizontal alignment possibilities. The latter will be affected by optional transit station locations, location of a MetroLink yard facility, and design options for possible new I-44 ramps.

Forest Park Circulator

The alternatives for an improved circulator for Forest Park are primarily operational concepts, involving use of "vintage" rubber tired vehicles following various routes with a limited amount of facilities to be built. The alternative routes reflect service to different market or user groups. Configurations are identified which employ single vs. multiple routes, internal (to the Park) and external (at edge of Park) routes, and time-managed routes reflecting service needs for typical daytime uses or for events on evenings/weekends.

Screening Results

The following results are organized according to the three areas of the corridor. Information using the screening criteria and range of choices under consideration are summarized as follows;

Forest Park Station through University City

1. Constructability
   a. Potential Right-of-Way
      The design concepts include below ground and at-grade alternatives. Space (width) requirements for such concepts would be:
      - At-grade
      - Two parallel LRT tracks = 30' (15' track center plus 7' 6" minimum horizontal clearance)
      - Separator median between tracks and lanes = 1' min. each side.
      - Side platforms = 10' each side.
      - Center platform = 16.5' (one).
      - Space needs (width) = 32' (minimum) (not at stations).
        =40' - 5" to 43' - 4"' (at stations/side or center platforms).
      - Underground
      - Width of tunnel or open cut structure = 36' (not at station).
      - Center platform = 16.5' (one).
      - Space needs (width) = 47' - 4" (minimum) (at stations).
      - Depth = 30'[2]

[2]Minimum depth is sufficient to provide for needed height between top of rail and catenary plus roof structure (for cut and cover) or clearance to grade level (for open cut).

The existing right-of-way along Forest Park Parkway and Millbrook Boulevard is mostly 90 feet (see cross section sketch on following page). The below ground option would fit within (under) this existing right-of-way. Various utilities are present, and must be either avoided or modified to be compatible with the transit structure.

For the at-grade concept in a median location, the two track width with minimum separators requires 32 feet. The road is a four lane facility requiring 48 feet plus 10 feet for a left turn lane at various locations. Sidewalk and/or outside edge clearance zones could require 5' on each side of the road. Roadway space needs (width) would be 58'. The total width requirements for transit and roadway would be:

- 90' where a left turn lane is not required.
- 100' where a left turn lane is required.

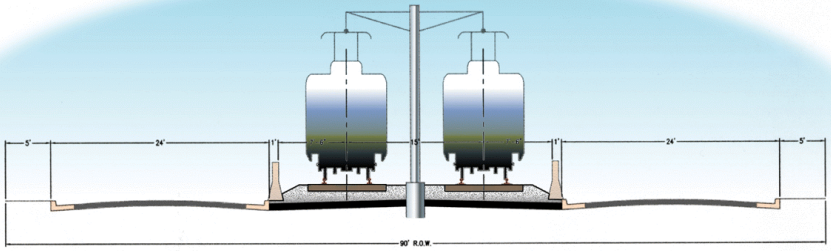
At transit station locations, additional space would be needed. For stations at a major intersection (such as Skinker Boulevard or at Big Bend Boulevard), the transit station platforms could be placed at the far side of the intersection, i.e., west of the intersection for the westbound track and east of the intersection for the eastbound track. For such layouts, the total roadway and transit track/platform width requirement would be 104'. If center platforms were used, the width requirement would increase to 116'.

In comparison to available right-of-way, the transit track zone and four lane street could be accommodated. In certain intersections requiring the addition of left turn (and/or right turn) lanes at the transit station, additional right-of-way is needed in the range of 10' to 26'. Such additions would be of only limited length in the vicinity of intersection approaches or stations, and appear possible at this time.

b. Alignment Attributes

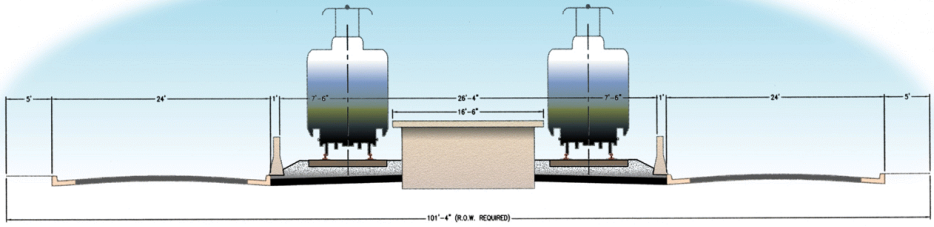
The alignment is essentially straight using Forest Park Parkway and Millbrook Boulevard. The curve at Pershing/Wellesley is easy to accommodate using MetroLink design standards. The change in vertical elevation at the east end of this area is readily possible, i.e., between below grade at DeBaliviere with possible coming up to surface level west of DeBaliviere.

For the underground alternative, the existing River Des Peres tunnels represent a potential obstacle. The difference in elevation between the top of the tunnels and the ground surface may not be great enough to accommodate a transit structure. However, some vertical alignment adjustments may be possible to overcome this concern.



MILLBROOK DOUBLE TRACK – AT GRADE

Not To Scale



NOTE:
DESIGN (SIZE AND SHAPE) OF TRACK BED AND THE MEDIAN BETWEEN LRT TRACKS AND TRAFFIC LANES IS VARIABLE DEPENDING ON ALIGNMENT CONDITIONS

MILLBROOK DOUBLE TRACK – AT GRADE – CENTER PLATFORM (SPACE FOR TRAFFIC LEFT TURNLANE NOT INCLUDED)

Not To Scale

MILLBROOK BOULEVARD CROSS SECTIONS / MEDIAN LOCATION

2. Operations

a. MetroLink would be accessed via three stations in this area, i.e., Forest Park, Skinker Boulevard and Big Bend Boulevard. The alternatives offer the same station locations with no difference in accessibility.

b. The at-grade concepts pass through two major intersections. These intersections are also station locations so that trains in either at-grade or underground alignments would stop. There is a difference in the running speeds between trains at grade and underground, with the surface concept having somewhat slower speeds consistent with street traffic and safety. There are few driveways and local street intersections in this area so that train operations could operate without conflict with other traffic.

c. As indicated above, the right-of-way could continue to contain the same number of traffic lanes as existing. The passage of LRT trains through the two major intersections will require modification of traffic signal operations, i.e., a special traffic signal phase for east - west train movement. Traffic volumes on Skinker Boulevard are in excess of 30,000 vehicles per day, approximately 26,000 vehicles per day on Forest Park Parkway, approximately 20,000 vehicles per day on Big Bend Boulevard. Traffic operations and capacity analysis indicate that peak hour volumes are high with existing delays. The design concepts could include means to enhance street capacity via grade separations or through lane underpasses for the north-south arterials.

d. As noted above, there are few intersections and driveways along the route. The opportunity exists to maintain that access for each concept identified for this area

3. Displacement

As noted above, there is a potential need for limited additions to the right-of-way along the route to accommodate the at-grade concept. There appears to be no displacement required with the possible exception of a strip of land at the northwest corner of Big Bend Boulevard at Millbrook Boulevard. Some portion of the commercial property at this location may have to be acquired.

One alignment option is to locate the MetroLink tracks along the south side of Forest Park Parkway/Millbrook Boulevard from west of DeBaliviere Avenue to Big Bend Boulevard. This could require the acquisition of right-of-way or easement from Washington University. Such action would also include removal of some existing campus buildings. Such right-of-way opportunity has been discussed by the University and therefore, would not be considered a fatal flaw.

4. MetroLink Extension

The new rail line connects to the existing MetroLink tracks in the vicinity of the Forest Park Station. All alternatives provide this connection in a similar fashion.

Clayton and the Galleria Area

This area of the corridor is more complicated than the other areas of the Segment I corridor. Alternatives are discussed in terms of three sections:

A. Clayton Downtown.
B. Brentwood/CMT Corridor.
C. Galleria.

A. Clayton Downtown

1. Constructability

a. Potential Right-of-Way
(Refer to figures on page 11)

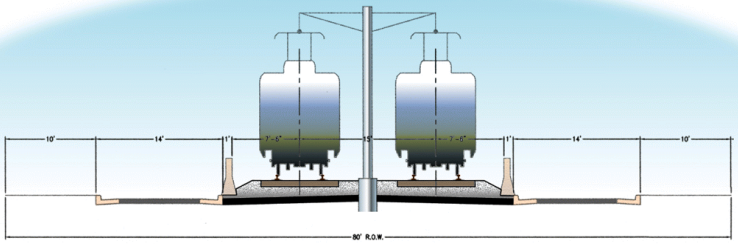
Street right-of-way width along the three east-west downtown streets (Forsyth, Carondelet, Bonhomme) is 80 feet. For these streets, the right-of-way width left available for the roadway and sidewalks using the at-grade concept would be 48 feet (no stations) and 35' to 36' at transit stations. Sidewalk areas would be 6' to 10' on each side of the street leaving 14' to 18' in each direction for vehicle traffic (no transit stations) and only 7 to 11 feet each direction for vehicle traffic where mid-block transit stations are placed.

Traffic usage on the three streets is significantly different, i.e.,

- Forsyth Boulevard = 10,000 vehicles per day.
- Carondelet Avenue = 4000 to 7000 vehicles per day.
- Bonhomme Avenue (no data - estimate volume similar to Carondelet).

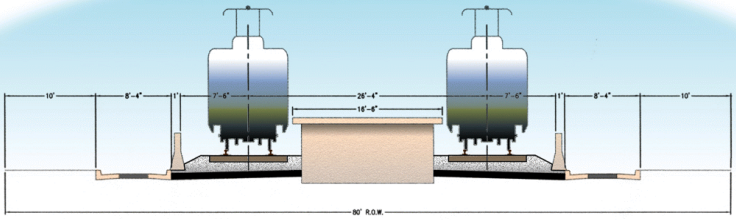
Each street has curb parking on both sides of the street. Forsyth has two lanes in each direction. Carondelet and Bonhomme have a varying pattern of one or two lanes per direction.

Specific assessment of conditions along each street follows:



CLAYTON DOUBLE TRACK – AT GRADE

Not To Scale



NOTE:
DESIGN (SIZE AND SHAPE) OF TRACK BED AND THE MEDIAN BETWEEN LRT TRACKS AND TRAFFIC LANES IS VARIABLE DEPENDING ON ALIGNMENT CONDITIONS

CLAYTON DOUBLE TRACK – AT GRADE – CENTER PLATFORM

Not To Scale

CLAYTON CROSS SECTIONS / MEDIAN LOCATION

Forsyth Boulevard

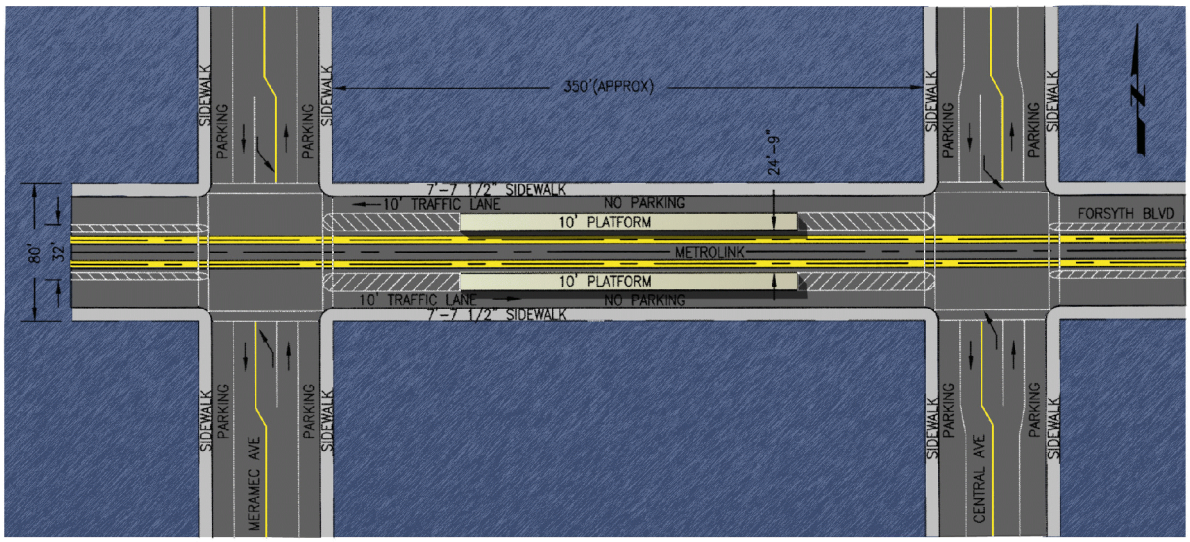
For the at-grade concept, the layout of tracks and lanes provides for two 10 foot traffic lanes in each direction. There is no space to develop separate left turn lanes. Curb parking is prohibited unless the traffic lanes would be limited to one per direction.

There would be a serious problem concerning the location of a transit stop (see plan view on page 13). The extra space required for the platforms would reduce pavement width to one lane in each direction. Since the platforms must be 200 feet long and block lengths between Bemiston and Meramec are 350' and 400', the station would take up most of the block. The intersection approaches could regain the two lanes in each direction for 75' to 100' in advance of the intersection. Street capacity would be controlled, however, by the single lane section in mid-block.

This situation could be modified if the sidewalk and platform jointly use the same space. This requires placing the tracks in each curb lane, leaving the center of the street for traffic flow. The curb lane location requires two catenary (wires) systems on the street. Driveway access needs to be carefully designed.

Another option is to eliminate the transit stop along Forsyth Boulevard. An alternative station location might be on Meramec Avenue or Brentwood Boulevard. The former entails the location alternative where the transit tracks turn onto Meramec Avenue and extend south to Shaw Park Drive.

For the underground concept in Forsyth Boulevard, there is no known right-of-way limitation. The transit facility could be built within the existing right-of-way. The construction impacts could be potentially severe on the adjacent land-uses. Many of the land-uses are small retail/commercial enterprises. Construction would cause significant access interruption and impact business activities. There could also be significant utility modifications that would increase construction impacts.



POSSIBLE FORSYTH BLVD METROLINK STATION

Carondelet Avenue

For the at-grade alternative, the same overall comments, noted for Forsyth Boulevard, would apply to Carondelet Avenue in terms of space needs. With transit tracks in the middle of the street right-of-way, there would be space for one or two traffic lanes in each direction or one traffic and one parking lane.

There are two significant differences between Carondelet and Forsyth. The traffic volumes are significantly lower so that one traffic lane could provide enough peak hour capacity. The land-uses along the street are high density office buildings and some residential. Most properties have off-street parking. The loss of curb parking would not be as significant as along Forsyth Boulevard with its retail frontage.

Second, there is an opportunity to locate a core transit stop that would not have the same space problems as along Forsyth Boulevard. In the block between Central and Meramec Avenue, St. Louis County is considering a redesign of its plaza. This would include a plan to eliminate vehicle traffic on Carondelet. As such, a transit station could be developed without the need to maintain traffic lanes.

As with Forsyth Boulevard, the underground concept can be developed within the existing right-of-way. Further, because the land-uses are different, the impacts of construction may not be as difficult to manage as compared to Forsyth Boulevard.

Bonhomme Avenue

Since the preparation of the technical papers describing various transit concepts, information has been obtained about a major office development project located on the east side of Hanley Road at the Bonhomme Avenue intersection. This possible project would eliminate the right-of-way opportunity to connect the east end of Bonhomme Avenue to the transit track location at the east edge of the downtown (near Forsyth at Forest Park Parkway). Even without this potential right-of-way problem this concept has other issues. The use of Bonhomme Avenue, as a location, requires an extensive grade-separated connection (elevated or underground) from the east edge of downtown to Hanley Road. The transition from elevated or underground to surface will require a major transition structure in the block between Hanley and Bemiston. These structures would reduce space for traffic lanes on Bonhomme. It is likely that the undergroud option would extend the transition west of Central. The elevated transition would likely require columns and elevated structure all the way to Bemiston. The capital cost and ease of access advantages of a Bonhomme Avenue at-grade location will be lost because of these linkage and transition requirements.

Forest Park Parkway

This segment is an elevated design concept. The MetroLink tracks would be located in structure placed along the north edge of Forest Park Parkway through the downtown area. In the section from Forsyth Boulevard to Hanley Road the transit structure would be over service driveways adjacent to the north edge of the roadway structure and in some sections (at the Ritz Carlton Hotel and just east of Hanley Road) it would be elevated over the westbound exit ramp (at the hotel) or over the westbound roadway (at Hanley). West of Hanley Road, the transit structure would be elevated over Shaw Park Drive. The right-of-way would be sufficient to accommodate this concept.

b. Alignment Attributes

The alignment through the Clayton downtown is essentially straight except at the west end where tracks must turn. The vertical grades in downtown are significant. These are acceptable for LRT design. However, the detailed design of the vertical profile for LRT tracks will produce some impacts relating to pavement elevation. These vertical grades would only affect the at-grade concept, since the profile of the underground concept can be selected to achieve desirable gradients.

The turns required at the west end of downtown will cause a geometric problem. In order to negotiate turns at reasonable speeds, i.e., for the at-grade concept this would be consistent with normal downtown street speed, the minimum track curvature would be a 125 foot minimum radius. With downtown streets having an 80 foot right-of-way, turns for tracks located in the center of streets would just barely be able to turn between two intersecting streets (at 90 degrees) without encroaching on the right-of-way line at the "inside corner" of the curve. The track would encroach, however, on the normal sidewalk zone at the corner. For traffic control purposes lane configurations and the location of the stop line for other traffic would need to be significantly changed from normal positions at an intersection because of the large radius curvature of the tracks.

Forsyth

Relative to above-described alignment issues, the use of Forsyth Boulevard has significant problems. These would affect the at-grade concept only. Concerning the vertical curvature, the steep grade and the change in grade near Bemiston is a problem. The vertical curves required for the transit track do not match the existing pavement elevation. This is likely to occur in the intersection area. Potentially significant alteration in pavement grades would be needed. These could produce some difficult problems for sidewalk grades and matching the grades of adjacent land-use.

The horizontal alignment is a problem for the Forsyth alignment concerning turning into Meramec Avenue or Brentwood Boulevard. At Meramec Avenue, the issue concerns both the relationship of the curve to the southeast corner of the right-of-way (at Forsyth and Meramec) and the relationship to a possible transit stop in the block between Meramec and Central. This block is 350 feet long; the platform is 200 feet long. If the station is at the center of the block, the end of the platform is only 75 feet from the Meramec right-of-way. In order to achieve a minimum 125 feet curve into Meramec, the curve needs to begin 100 feet from the right-of-way line, i.e., the curve would encroach on the platform. The platform could be moved eastward, but this would impact street lane geometry at the Central Street intersection, i.e., eliminating potential for two eastbound traffic lanes at Central Avenue.

Carondelet Avenue

Again, the underground alignment is not affected by these alignment issues. For the at-grade, the vertical curve problem, as described above, would occur in the mid-block between Hanley and Bemiston where track and street elevations probably won't match. It is likely that the track zone would be placed in a barrier median. Left turns across the median would be prohibited. However, this element would be in mid-block between Bemiston and Hanley and should not impact intersection operations.

The horizontal curvature problem also affects Carondelet Avenue. The turn at Brentwood Boulevard will potentially create sidewalk encroachment at the southeast corner (for the option to go south) or for the northeast corner (for the option leading to Maryland Avenue). This encroachment could be mitigated somewhat by locating the tracks at the west edge of the Brentwood Boulevard pavement rather than in the center of the street.

For the turn onto Meramec Avenue, the difference for Carondelet, compared to Forsyth, is that the station and tracks can be positioned in the block between Central and Meramec to facilitate the turn onto Meramec. That is, the tracks can be moved to the north side of the Carondelet right-of-way and the platform moved closer to Central. Also, Meramec Avenue has a 90 foot right-of-way. The tracks could be placed along the west side of the street to facilitate the curve.

Forest Park Parkway

The alignment along the Parkway is essentially straight without any horizontal curvature problems. Vertical curves can be introduced using appropriate standards.

2. Operations

a. Transit is accessed via two stations in the Clayton downtown; one located in the vicinity of Forsyth Boulevard at Forest Park Parkway and one in middle of downtown (vicinity of Central or Meramec). The former station is common to all alternatives.

The core stations would be in different positions for the three remaining (i.e., excluding the Bonhomme route) alternative alignments.

Forsyth Boulevard

This station location, on Forsyth, is close to major downtown trip attractions; it is north of the concentration of trips associated with major office building and the county government center. As noted above, there are right-of-way problems in locating a station on Forsyth. Eliminating the core station to overcome right-of-way constraints would seriously compromise the accessibility of transit.

Carondelet Avenue

The potential station would be in the heart of downtown. Based upon the destination (by block) of office space (employed locations) and other major trip attractions, this location would have the lowest average walking distance between trip destination and transit.

Forest Park Parkway

The potential station would be at the south edge of the downtown. Physically, it could be coordinated with a large proposed county parking structure. However, the station would be 700 feet south of Bonhomme and 1200 feet south of Carondelet. This extra walking distance could be mitigated by developing an attractive pedway along Central Avenue, Meramec Avenue, and within the block. The latter could include joint development opportunities as well as means to provide a level (rather than uphill) walk path.

b. Transit operations would be significantly different between the at-grade and grade separated design concepts. For the underground alignment along Forsyth or Carondelet, transit speed/travel time would be controlled by the time spent stopping at two stations and speed limitations in negotiating potential 90 degree turns at Brentwood Boulevard or at Meramec Avenue. For the Forest Park Parkway route, only time stopped at stations would impact speed since the alignment on this section is essentially straight.

For the at-grade concepts for Forsyth or Carondelet, transit operations are integrated with traffic operations. This would cause some delays and slower speed operations. An improved traffic signal system would be needed to manage transit and traffic flow.

Forsyth Boulevard

As noted in the right-of-way discussion, street operations would be affected via the reduction of traffic lanes. Because there is no realistic opportunity to widen the right-of-way, the total width of the street is fixed. Given peak hour traffic flows, it would be expected that traffic delays would increase at the five primary intersections in the core.

Transit speeds would be affected by the presence of pedestrian traffic along Forsyth. As a retail-oriented street, there is a concentration of people activity. Traffic controls would be designed to manage pedestrian traffic, but it does represent a further risk to slow transit flow to below normal street speeds.

Carondelet Avenue

This street has significantly less traffic in terms of both vehicle and pedestrian traffic. It is more likely that transit will be able to maintain normal street speeds, consistent with traffic signal operations, along this street. There would have to be new investments in signal installations. Existing stop sign controlled intersections would need to be signalized to provide for needed traffic management.

c. Because of the difference in peak hour volumes and right-of-way conditions, the risk of increased traffic congestion is more likely along Forsyth than Carondelet. Preliminary traffic capacity indicates that level of service D or better is possible along Carondelet.

d. There are different land-use access conditions between Forsyth and Carondelet. Each street contains access to public alleys, public and private parking facilities and truck loading docks. A recent inventory indicates that Carondelet has more driveway access along its length than Forsyth. There are more parking garages along Carondelet. Forsyth parking access tends to serve smaller facilities.

Forsyth has one unique access point, the Clayton Fire Department station. This facility provides emergency services for the downtown. While a possible transit alignment along Forsyth would not block fire station access, there is a potential problem with vertical grade at this location wherein track level and pavement elevation may not match well. This will affect the frontage at the fire station. Operationally, there is the risk that increased congestion along Forsyth could affect emergency response or emergency response activities could create delays to transit operations on a regular basis.

For each street, the position of the core station would not restrict access. It is possible that left turns could be maintained throughout the downtown. If left turns are not possible in some locations, the downtown street grid provides reasonable opportunities for around-the block circulation that would make right-turn in and out access workable. Along Carondelet, it is likely that mid-block left turns would be precluded by track elevations in the median (see previous note) in the block between Hanley and Bemiston.

3. Displacement

For this alternative in downtown, no displacements are anticipated. There is the possibility of needing some right-of-way (or easement) at the east edge of downtown for linkages into Carondelet Avenue. Such space would use currently vacant land and not cause displacement of active land-use. At the northwest corner of Meramec and Shaw Park Drive, one of the transit alignment options would include a curved elevated structure that would be ascending from the Meramec Avenue street level (south of Bonhomme Avenue) to be elevated over Shaw Park Drive. This curve could require displacement of an existing parking lot at this corner.

4. MetroLink Extension

The alignment in the downtown area does not include junctions with future transit extensions. A downtown junction might be desirable for a future Segment III Extension if trains are to run from Forest Park to Clayton, then north.

B. Brentwood/CMT Corridor

The section concerns the linkage between the west edge of the Clayton Downtown and the Galleria Area (in the vicinity of Brentwood Boulevard and Clayton Road).

1. Constructability

a. Potential Right-of-Way

The right-of-way needs for street locations (at-grade or underground) are the same as noted in the previous discussion for the Clayton downtown.

The options for the linkage between the downtown area and the Galleria are three:

- Brentwood Boulevard south from Forsyth or Carondelet to the CMT right-of-way north of Clayton Road or at Galleria Parkway.
- Forest Park Parkway/Shaw Park Drive to the CMT right-of-way and south on the CMT.
- Forsyth to Maryland Avenue to the CMT right-of-way and south on the CMT.

For the CMT right-of-way, there is no right-of-way constraint other than the location of the Union Electric transmission towers in this space. The width of the CMT right-of-way varies between 30 to 100 feet. There may be a need to relocate some towers or even acquire right of way in some locations where the width is only 30 feet. These are limited situations, and will not prevent use of the CMT right-of-way. Similarly, there is no apparent right-of-way constraint related to the Forest Park Parkway/Shaw Park Drive alignment. Using Brentwood Boulevard or the Forsyth/Maryland Avenue alignment, right-of-way constraints are possible.

Brentwood Boulevard

The street has a right-of-way for a six lane wide pavement (including parking lanes) plus sidewalks on both sides. For the below ground option, this right-of-way would be sufficiently wide to contain the transit structure. For the at-grade option, the transit tracks would reduce available space for traffic and parking. The basic change would be to eliminate existing curb parking and the right turn lanes. The remaining pavement would include four traffic lanes and one left turn lane. Land along Brentwood Boulevard is completely built up plus Shaw Park is on the west side of Brentwood Boulevard north of Forest Park Parkway. No additional right-of-way would be available without significant displacement except for possible minor adjustments at corners (e.g., rounding to accommodate turning tracks at Forsyth or Carondelet).

At the southern end of this section, Brentwood Boulevard intersects the CMT right-of-way north of Clayton Road. The tracks could rise from underground or surface via an elevated structure to connect to the CMT right-of-way. Such a transition structure requires significantly new right-of-way along the east side or west side of Brentwood Boulevard. The former would cause residential displacement; the latter would displace existing parking and access roads serving the Clayton Corporate Center.

The transit alignment could proceed past this point to access the CMT right-of-way at Galleria Parkway. Brentwood Boulevard passes under the CMT right-of-way and I-170 bridges. These structures have a center support column and two portals, each with three traffic lanes. Just south of these bridges, a southbound exit ramp from I-170 merges with Brentwood Boulevard as well as the approach into the Clayton Road intersection. The latter contains one left turn, one right turn, and two thru lanes. There are two northbound lanes.

The at-grade option uses one traffic lane in each direction under the CMT/I-170 bridges. The remaining two lanes in each direction would be only 9 to 10' wide. There could be a safety issue because of the limited clearance. In the Clayton Road intersection approach, the right turn lane would be removed to make space for the transit tracks. Some widening on the east side of Brentwood Boulevard may be required to maintain two northbound traffic lanes plus the transit track.

Forsyth/Maryland Avenue

These streets have right-of-way providing six lanes of pavement including two curb parking lanes. As with Brentwood Boulevard, the underground option could be accommodated. The at-grade option could be accommodated, but this would require elimination of all curb parking. At Gay Avenue, the Maryland Avenue pavement width narrows to four lanes plus a narrow left turn lane. From this point to the CMT right-of-way (about 600 feet), the pavement will need to be widened (including new right-of-way) to maintain pavement width plus the transit tracks. The land adjacent to the street is used for parking lots (strip shopping center on north side and bank/office buildings on south side). Some parking space would be eliminated in this widening, but no buildings would be displaced.

At the junction with the CMT right-of-way at Maryland Avenue, the transit tracks would turn into the CMT right-of-way. This curve also requires right-of-way from the parking lots adjacent to the bank/office building.

b. Alignment Attributes

For the Brentwood Boulevard and Forsyth/Maryland Avenue below grade options, there are no alignment (horizontal curvature or vertical grade) problems. For the at-grade options, there are no vertical curve problems but there are possible horizontal curvature problems. The Forsyth/Maryland Avenue alignment would be a longer route (approximately 3600 LF).

As noted in the previous discussion of curvature (see Clayton downtown section), a minimum 125' radius for transit track design is to be used. For Brentwood Boulevard, the linkage between the Forsyth Boulevard and Carondelet alignments would be difficult. These would occur at the southeast corners of each intersection by virtue of possible track encroachment on the sidewalk. This would be a problem at Forsyth because the existing office building at the corner has little setback. At Carondelet, the building has a diagonal setback at the corner that could permit some sidewalk modification at the corner.

For the Forsyth/Maryland option, similar 90° turn problems would exist at Forsyth/Brentwood, Carondelet/Brentwood, and Brentwood/Maryland Avenue. With a Forsyth Boulevard location in downtown, tracks could continue on Forsyth across Brentwood following the curved street alignment to Maryland Avenue. This path would not have turning radius problems. With a Carondelet Avenue location in downtown, tracks would have to include two 90° turns in order to reach Maryland Avenue. These will entail sidewalk encroachment problems.

2. Operations

a. No transit station is currently planned for this section of the corridor. There is a potential for a future station in the Maryland Avenue corridor. Such a station could be located on the CMT right-of-way near Maryland Avenue or on Maryland Avenue. The latter, however, would increase right-of-way acquisition needs and be a more significant problem.

b. Transit operations are satisfactory for the alignments along the CMT right of way. The same would be true for the underground options along Brentwood Boulevard and Forsyth/Maryland Avenue. As with the downtown section, speeds for the at-grade options would be affected by traffic conditions. For the Brentwood Boulevard route, the route would pass through five signalized intersections; the Forsyth/Maryland Avenue route would have five signalized intersections (including a new one at the CMT right-of-way access point). The route along Brentwood Avenue has a limited number of driveways, but has seven local street intersections. The route along Forsyth/Maryland has many more driveways and only four local street intersections. Each of these locations potentially generate left turns across the track zone. Brentwood Boulevard has a "closed loop" traffic signal system in which signals can be operated to achieve progressive flow along this street. This would facilitate transit speed.

c. Traffic flow along Brentwood Boulevard and Forsyth/Maryland have similar magnitudes (20,000 to 25,000 vehicles per day). These volumes require at least four traffic lanes to achieve needed traffic capacity. While the need for allocating signal time to transit at signalized intersections will somewhat decrease green time for other traffic, the impact could be potentially manageable. The risk is that volumes in the vicinity of the I-170 (where Maryland Avenue joins Ladue Road) will continue to increase and affect traffic operations in the westerly part of this option.

Along Brentwood Boulevard, traffic capacity could be maintained since the basic through lane cross-section will be preserved. There is delay potential associated with loss of right turn lanes on Bonhomme and Shaw Park Drive. The greater traffic congestion problem would occur at Clayton Road. Volumes on Brentwood Boulevard south of Clayton Road are substantially higher at 46,000 vehicles per day. It is likely that delay will significantly increase at this intersection.

d. Land-use access needs are significantly different between Brentwood Boulevard and Forsyth/Maryland Avenue. These are as follows:

<u>Forsyth/Maryland</u>

- There are 13 mid-block driveways plus the local street intersections.
- The small retail land-uses located along Maryland east of Brighton Way are dependent on the existing curb parking space.
- The pattern of streets doesn't provide around-the-block circulation opportunities to provide access if left turns are not possible for traffic management/safety reasons.

<u>Brentwood Boulevard</u>

- There are less than five mid-block driveways plus local street intersections.
- Land-uses are office and permanent residential; curb parking is not as critical as for small business enterprises.
- Around-the-block circulation is available for the section north of Forest Park Parkway but not to the south.

3. Displacement

There is the potential need for additional right-of-way. This would be focussed at the key intersections (Brentwood Boulevard at Clayton Road), creating a transition to an elevated structure from Brentwood Boulevard to the CMT right-of-way, and road sections (Maryland Avenue from Gay Avenue to CMT). It appears that these right-of-way needs will not displace active land-uses except for parking space. The vertical transition to the CMT from Brentwood Boulevard would create a significant displacement impact and would probably not be acceptable.

The Forest Park Parkway/Shaw Park Drive route may cause some displacement in the City of Clayton maintenance yard, located east of I-170 and south of Forest Park Parkway. The transit line would be on elevated structure. Support columns could be located to minimize disruptions to yard facilities and operations.

4. MetroLink Extension

Brentwood Boulevard

This alignment crosses under the CMT right-of-way just north of Clayton Road. If Segment III were developed using the CMT right-of-way extending north from Clayton, a junction with Brentwood Boulevard at this point would not be reasonably constructible. The Brentwood Boulevard alignment would extend south to Galleria Parkway and then east to the CMT right-of-way. At this point, a junction with Segment III could occur. Room for the track junction is very limited and could be a problem. Possible inter-route transfers would require another station or be allocated to the next station to the south at Eager Road.

Forsyth/Maryland Avenue

This alignment would directly link with the Segment III extension and possible west corridor. The junction, however, would be at-grade in the vicinity of Maryland Avenue and the I-170/Ladue Road interchange. Additional MetroLink train traffic is likely to occur at the junction. Because of the convergence of two MetroLink routes, more traffic signal time would be required with an increased risk for congestion. Tracks could be grade-separated along the CMT, but this would also require including grade-change structures along Maryland Avenue. This would require added right-of-way and would restrict some left-turn access.

Forest Park Parkway

This alignment would directly link with Segment III in the vicinity of I-170. The junction would be completely grade separated and would not entail any constructability problems or impacts on street traffic. Passengers transferring between routes would need to use the Galleria station and possibly the Clayton downtown station.

C. Galleria

For this third section, the alignment options are the CMT right-of-way and Brentwood Boulevard. The former would be at-grade; the latter could be at-grade, underground, or elevated along an alignment just east of the Brentwood Boulevard right-of-way as part of a new development site.

1. Constructability

a. Potential Right-of-Way

The CMT right-of-way is sufficient for the transit facility. For Brentwood Boulevard the right-of-way is sufficient for the underground concept. The elevated option is conditioned based upon opportunities for a new development project that would physically integrate the transit structure and station.

For the at-grade option along Brentwood Boulevard, the presence of the transit tracks would reduce the roadway pavement to five lanes. In order to preserve the existing cross section, added right-of-way would be needed. Galleria parking lots abut the alignment along the west edge while small commercial land-uses and parking areas are along the east edge. It is possible that limited right-of-way expansion could be accomplished, although some displacement may occur.

b. Alignment Attributes

The CMT right of way does not create any displacement design problems. It is essentially a straight section. The Brentwood Boulevard alignment would have no vertical grade problems. It has a 90° turn at Galleria Parkway. The required 125' minimum radius will potentially encroach on the sidewalk at the northeast corner of Brentwood and Galleria Parkway.

The elevated option, involving a combination alignment using the CMT right-of-way and Brentwood Boulevard and Galleria Parkway locations, would be able to employ proper vertical grade and curvature standard. Because of the height required to clear I-170 in two places, the elevated structure will be quite high. The risk for this concept is the uncertainty about market demand for a large scale development to be integrated with this transit facility.

2. Operations

a. Transit would be accessed by one station. For the CMT right-of-way option, this station would be east of I-170. This would access development east of the CMT right-of-way in a direct fashion. Access to the Galleria would be somewhat indirect and would require a pedestrian grade crossing of Brentwood Boulevard.

The Brentwood Boulevard underground option would have the station under Brentwood Boulevard at Galleria Parkway. Passenger access would be underground to both sides of Brentwood Boulevard. This would achieve a more direct linkage to the Galleria shopping center.

The Brentwood Boulevard at-grade option would have the station located on Galleria Parkway just east of Brentwood Boulevard. The station would not be located in Brentwood Boulevard because of the insufficiency of right-of-way to accommodate the additional width for platforms.

The elevated concept would have the station integrated with new development located east of the Brentwood Boulevard right-of-way. A second level pedestrian connection could be provided over Brentwood Boulevard to create a high quality pedestrian link to the shopping center.

b. Transit operations would be significantly different for the at-grade Brentwood Boulevard option relative to the other alternatives. The underground, CMT alignment, and elevated options would allow for high transit speeds. The need for stopping at the station and horizontal curves would be the controlling factors.

The at-ground alignment would need to operate at street traffic speeds. Because of high volume of traffic on Brentwood Boulevard, there is potential for delay in transit operations on this alignment.

c. Traffic operations would be a problem in terms of increased delay and

congestion on Brentwood Boulevard south of Clayton Road in connection with the at-grade alternative. The other alternatives would not significantly affect traffic flow.

d. Access would not be affected by the alternatives. There are driveways along the east side of Brentwood Boulevard and along Galleria Parkway west of I-170. In an at-grade Brentwood Boulevard alignment all of these will be kept open, however, the location of the station platforms on Galleria Parkway will prohibit left turn access (in or out) for approximately 250' to 300' east of Brentwood Boulevard.

3. Displacement

Only the elevated option will potentially create the need for displacing existing active land-uses along the east side of Brentwood Boulevard between I-170 and Galleria Parkway. This could be part of site assembly for new/joint development project.

4. MetroLink Extension

The junction with future MetroLink Extension is not affected (or diminished) by the CMT alignment options. However, as noted above, the Brentwood Boulevard below ground and at-grade options would create problems for developing a Segment III (to north) extension.

D. Richmond Heights to Shrewsbury

This section has one design concept with two sections where options are identified. The basic concept is using the CMT right-of-way with an at-grade alignment. The two option areas are at the Sunnen Business Park (Flora Avenue to the Union Pacific railroad tracks) and the south end of Segment I from Big Bend Boulevard to Lansdowne Avenue (I-44 vicinity).

1. Constructability

There are no right-of-way or alignment attribute problems for the identified alternatives. The coordination with Union Electric towers will be a consideration that could cause either relocation of towers or acquisition of some new right-of-way in limited lengths.

2. Operations

a. Transit access will be different in relation to the location of the southern Segment I terminal station. Two options are identified: one station south of Big Bend Boulevard (north of I-44 and Deer Creek) or two stations (one at Big Bend Boulevard and one at Lansdowne Avenue). Accessibility patterns are different. Travel demand analysis will help determine if there are any differences in future transit ridership.

b. Transit performance is not significantly different for any alternative.

c. Traffic operations are affected by access to potential major park-n-ride facilities at the Eager Road/Hanley Road and southern stations. This consideration is not affected by the design options. It is affected by station location and will be part of the impact analysis of the alternatives.

The only option with traffic impacts is the at-grade crossing of Big Bend Boulevard. In this case, the transit line crosses the street but does not run along it. Major traffic problems are not anticipated.

d. Access would not be affected by the design concepts.

3. Displacement

Displacement is possible for all options in connection with park-n-ride at the Eager/Hanley Road station and at the terminal station and station site facilities at all station locations in this area. The transit line crossing the Deer Creek/I-44 area will require new right-of-way. Some displacement is possible.

4. MetroLink Extension

The anticipated Segment II extension to South County would potentially follow the BNSF rail line. All options allow for a connection to this line.

Summary

The following summarizes the above discussions concerning the screening criteria:

A. Forest Park Station through University City Area
   1. No alternatives to be discarded.
   2. Limited right-of-way may be acquired; no displacement anticipated.

B. Clayton and Galleria Area
   1. Forsyth Boulevard alignment has serious geometric and right-of-way problems.
   2. Bonhomme Avenue alignment may not be feasible due to lack of right-of-way for east linkage. The need for major transition structures in the blocks between Hanley and Central would significantly detract from the basic purpose of this location i.e.; ease of access and cost effectiveness.
   3. Brentwood Boulevard alignment, as at-grade, has serious right-of-way problems in the Clayton Road vicinity.
   4. Maryland Avenue alignment requires additional right-of-way. The attractiveness of Maryland Avenue severely diminishes if Forsyth Boulevard is not used through Clayton downtown. That is, a Carondelet - Maryland alignment adds an additional 90° turn, increases right-of-way problems and increased length of route.
   5. Carondelet - Meramec Avenue linkage offers an attractive connection for the at-grade concept.
   6. Forest Park Parkway elevated offers a distinctly different alternative with attractive transit performance potentials, although the downtown station would be a few blocks from the City center.

C. Richmond Heights to Shrewbury
   1. No alternatives to be discarded.
   2. Right-of-way acquisition needs for some stations will be significant.

Range of Choice

The above discussion explored constructability and operational considerations. This section addresses the objective to select candidate alternatives that provide a range of choice.

The choices implicit in this review are:

- horizontal location
- vertical alignment
- station location

The tradeoffs associated with these choices are cost, performance, benefits, and impact. Totally grade-separated concepts would facilitate transit speed, however such schemes would have higher capital costs. An at-grade concept would have lower capital costs and have high visibility and user convenience. Further, impacts would be different for the concepts; both in type, location, and extent of benefits and impacts.

For two areas of the Segment I corridor, i.e., Forest Park Station through University City and Richmond Heights to Shrewsbury, the horizontal location for all alternatives is essentially the same. The choices that remain involve vertical alignment concepts.

The Clayton and Galleria area is the more complicated section of the corridor. There are various combinations of horizontal and vertical alignments. The location through the Clayton downtown should consider the underground and at-grade options. This could be associated with one street as the best location from a constructability and operational perspective. As a completely different choice, the elevated option along Forest Park Parkway would be a useful concept to include for detailed study.

For the linkage from the downtown to the Galleria area, there should be an option between the Brentwood Boulevard and Forsyth/Maryland Avenue route. The Forest Park Parkway-to-CMT right-of-way should be kept as one of the alternatives. It represents a grade-separated choice with a different capital cost potential than underground or at-grade options.

4
Recommended Candidate Alternatives

Based upon the previously presented results, the recommended candidate alternatives are described in this section.

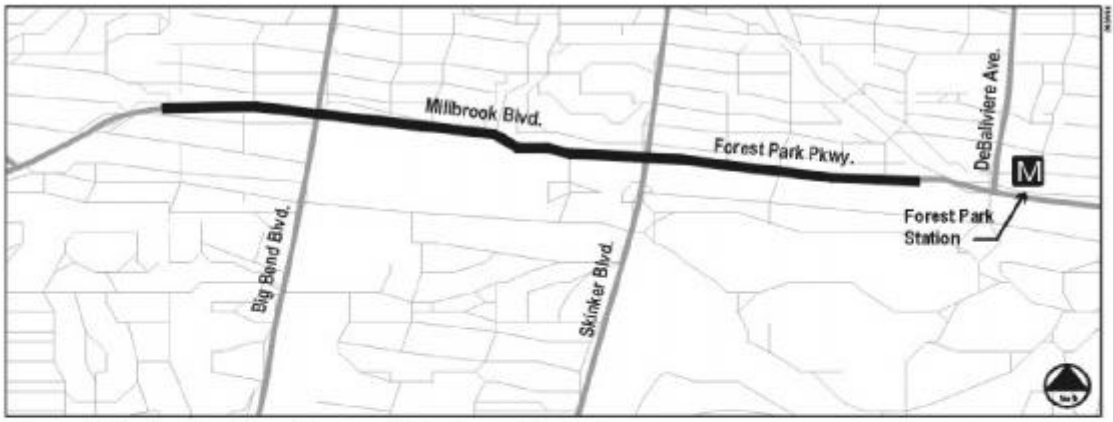
As a group, the alternatives satisfy the screening principals in terms of the criteria and range of choices. Individually these offer advantages and disadvantages.

Specific highlights of the alternatives are as follows:

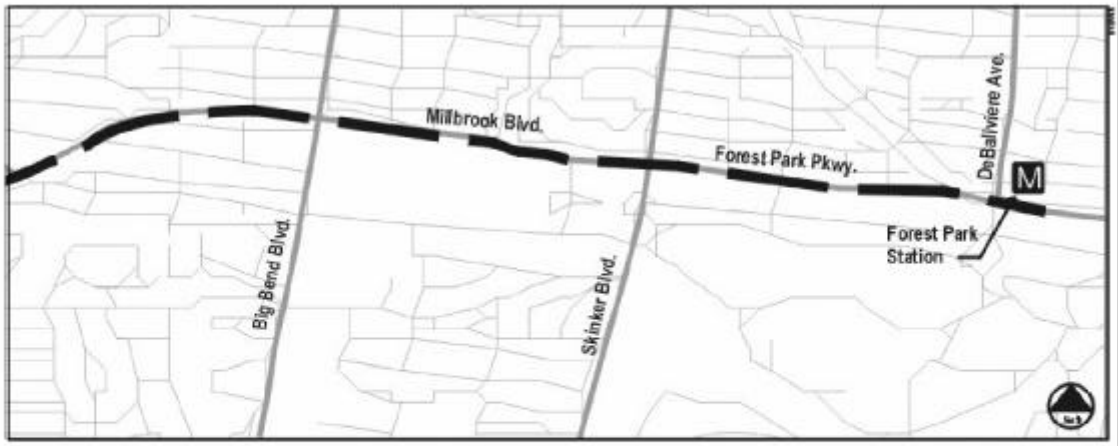
A. Forest Park through University City (Figures 1 and 2)

1. Underground alignment using cut and cover techniques with consideration of open cut if desirable and appropriate, for the entire length of this area.

2. At-grade alignment from west of DeBaliviere Avenue to a point just east of Wellesley/Pershing Avenue intersection; track location could consider median or edge of pavement positions. The sections from west of DeBaliviere to the existing MetroLink station and Forest Park Parkway from Wellesley/Pershing Avenue to Forsyth Boulevard would use an underground (cut and cover) concept.



Forest Park Station through University City
Candidate Alternative - Surface
Figure 1



Forest Park Station through University City
Candidate Alternative - Below Grade
Figure 2

B. Clayton and Galleria Area (Figures 3, 4 and 5)

1. Clayton Downtown Section

    a. Carondelet Avenue using both underground (cut and cover with some possible bored tunnel if necessary) and at-grade concept from Forsyth Boulevard at Forest Park Parkway to Meramec Avenue; the underground concept would continue to Brentwood Boulevard; the at-grade concept would turn onto Meramec Avenue and extend to Forest Park Parkway/Shaw Park Drive becoming an elevated concept at this location.

    b. Forest Park Parkway/Shaw Park Drive elevated concept from Forsyth Boulevard to the CMT right-of-way.

2. Clayton Downtown to Galleria Section

    a. Brentwood Boulevard from Carondelet Avenue to Clayton Road as an underground, cut and cover, concept.

    b. CMT right-of-way from Forest Park Parkway.

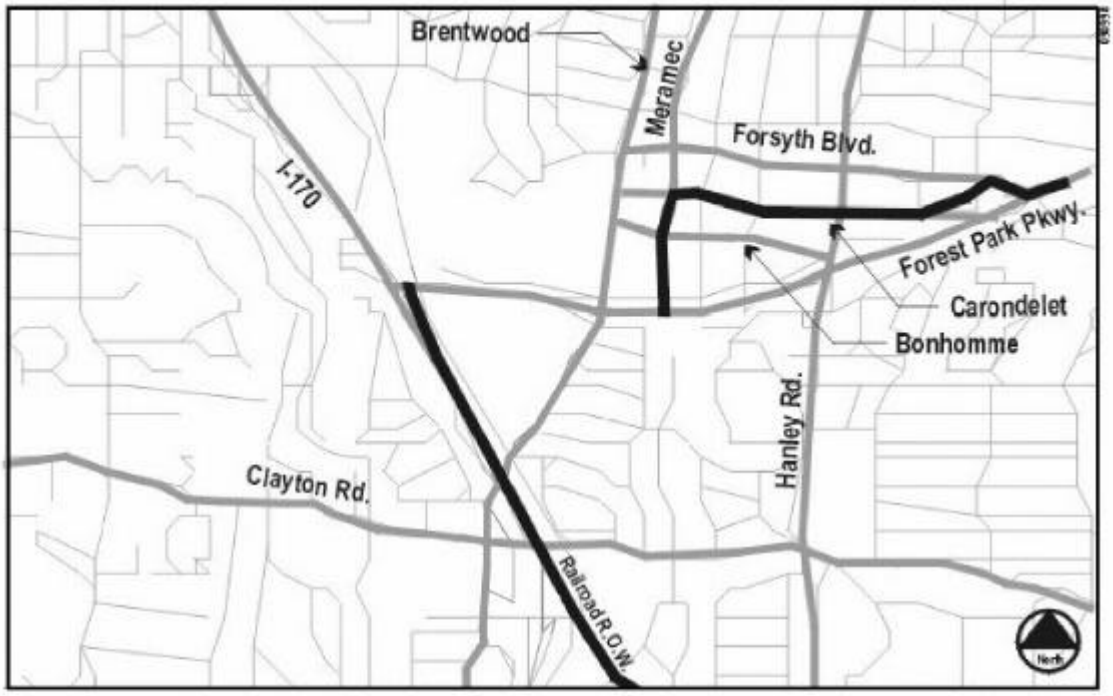
3. Galleria Section

    a. Brentwood Boulevard/Galleria Parkway as an underground, cut and cover concept.

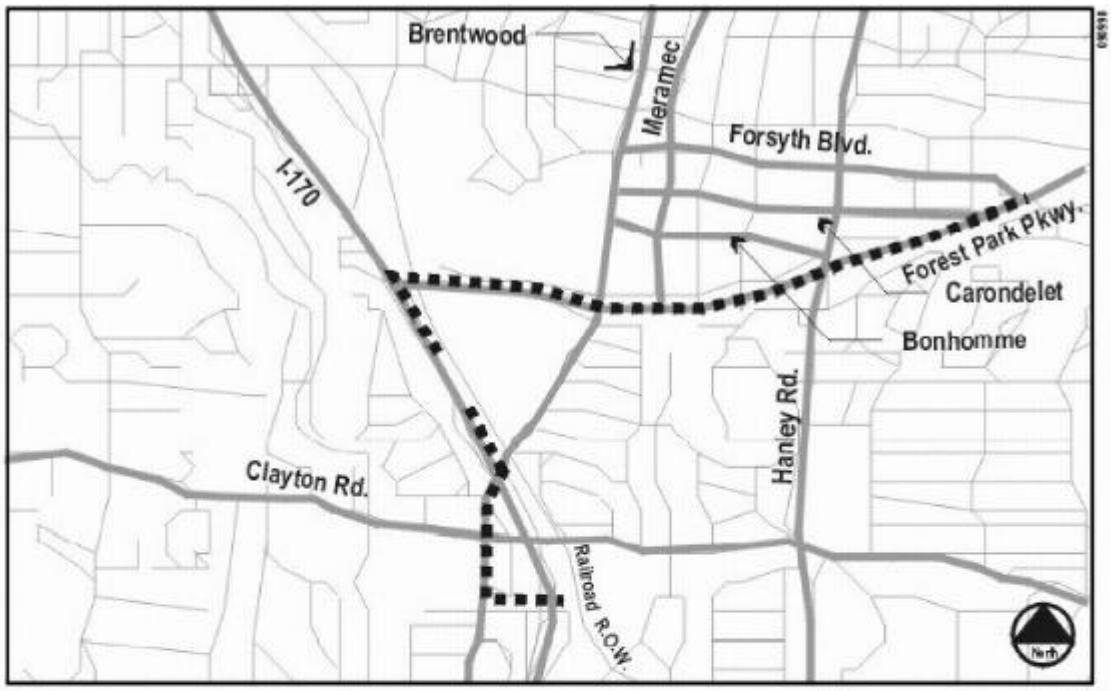
    b. CMT right-of-way.

    c. CMT/Brentwood Boulevard/Galleria Parkway as an elevated concept.

Note: If other at-grade options prove to be infeasible with further study then the Bonhomme at-grade option will be revisited.

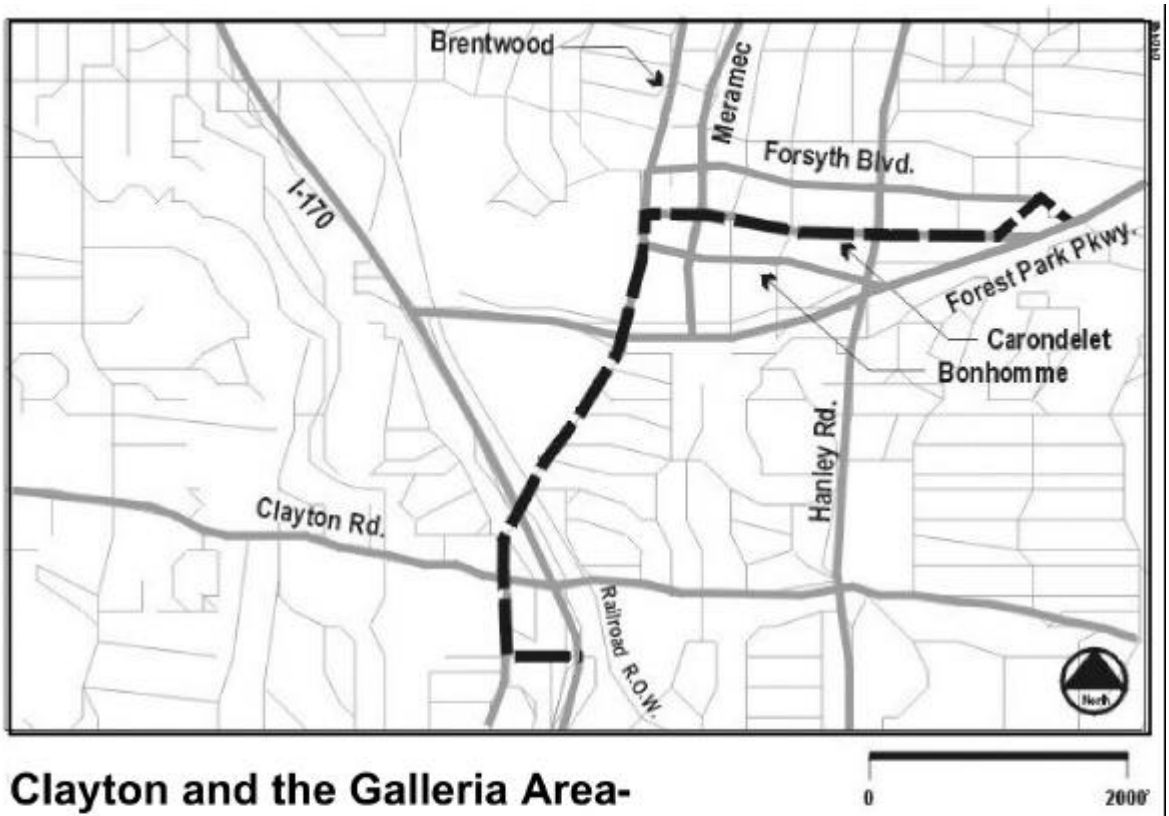


Clayton and the Galleria Area-
Candidate Alternative - Surface
Figure 3



Clayton and the Galleria Area-
Candidate Alternative - Elevated
Figure 4

0 2000'



Clayton and the Galleria Area-
Candidate Alternative - Below Grade
Figure 5

C. Richmond Heights to Shrewsbury Area (Figures 6, 7 and 8)

1. CMT right-of-way as an at-grade concept using alternative alignment options through the Sunnen Business Park via elevated and underground, cut and cover, concepts.

2. South end options including:

    a. Elevated from the Union Pacific rail line to Lansdowne Avenue.

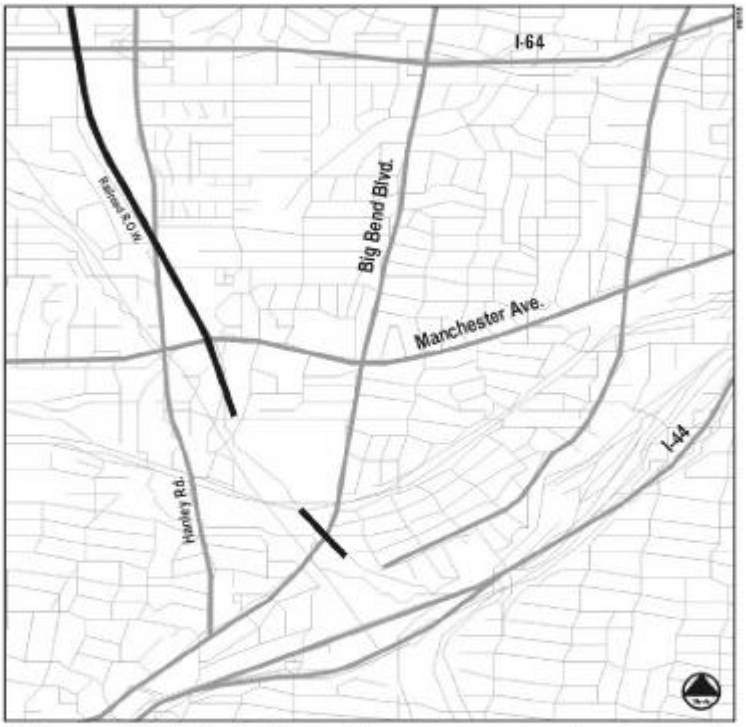
    b. At-grade from the Union Pacific rail line to Deer Creek, then elevated to Lansdowne Avenue.

    c. Optional station sets: one station at Deer Creek vs. two stations at Big Bend Boulevard and Lansdowne Avenue.

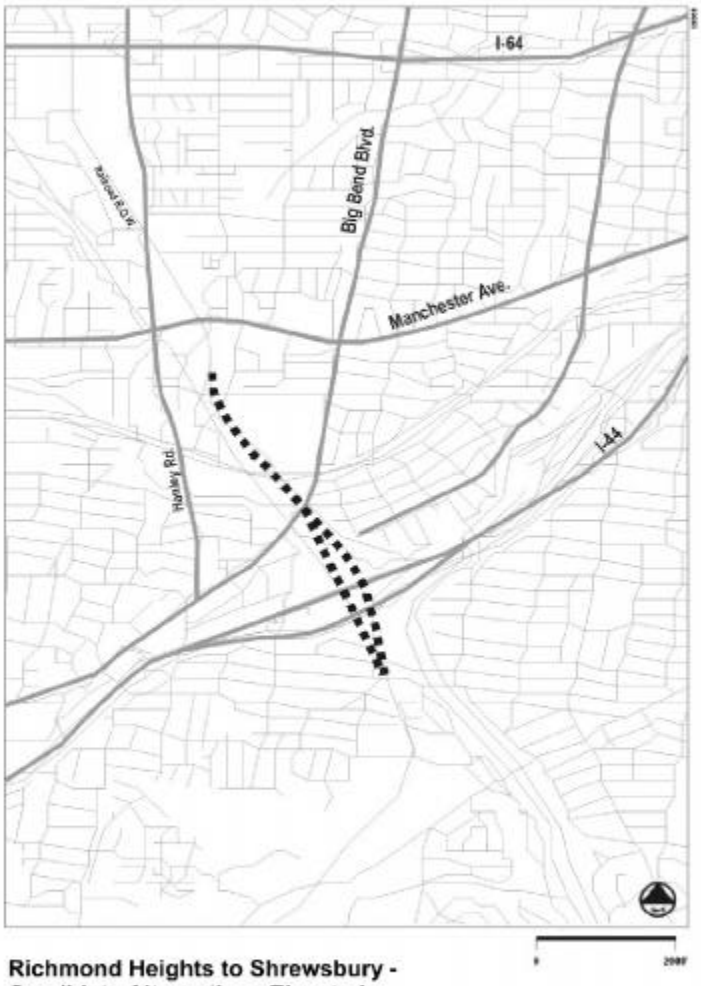
    d. Alternative I-44 access improvements via new ramps or new interchanges (configurations to be developed).

D. Forest Park Circulator

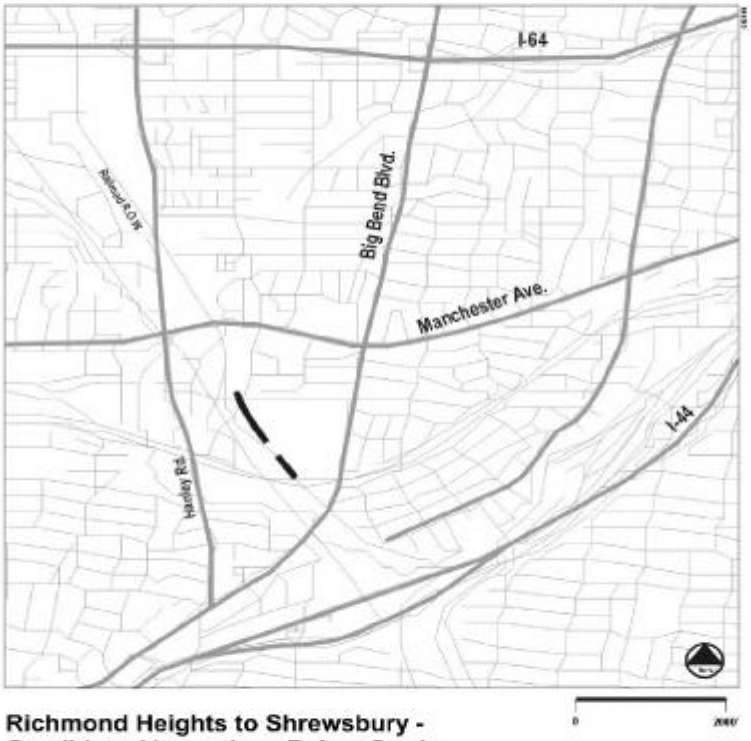
The alternatives for the Forest Park Circulator are mostly operational choices. It is not expected that many new physical facilities will be constructed, other than some stop facilities (canopies, simple shelters, etc.). It is recommended that all alternatives be carried forward for more detailed analysis.



Richmond Heights to Shrewsbury - Candidate Alternative - Surface
Figure 6



Richmond Heights to Shrewsbury - Candidate Alternative - Elevated
Figure 7



Richmond Heights to Shrewsbury - Candidate Alternative - Below Grade
Figure 8

Summary

The recommended set of candidate alternatives represent the following rationale:

1. All previously identified concepts would be retained for the east and south areas of the Segment I corridor. These represent a range of possible alternatives from an operational, impact and cost perspective.

2. The concepts in the central area (Clayton and Galleria) will eliminate options that would not be constructible or would have major operational problems. An alignment along Forsyth Boulevard, through the Clayton downtown, would have severe problems. Carondelet Avenue is clearly more attractive. At-grade concepts can be developed through the core of the City achieving high visibility and accessibility. However, at-grade operation on Brentwood Boulevard is problematic. A problem occurs at the I-170 underpass and at Clayton Road. For this reason, the Carondelet Avenue at-grade concept is linked to Meramec Avenue through which it transitions into an elevated concept along Shaw Park Drive.

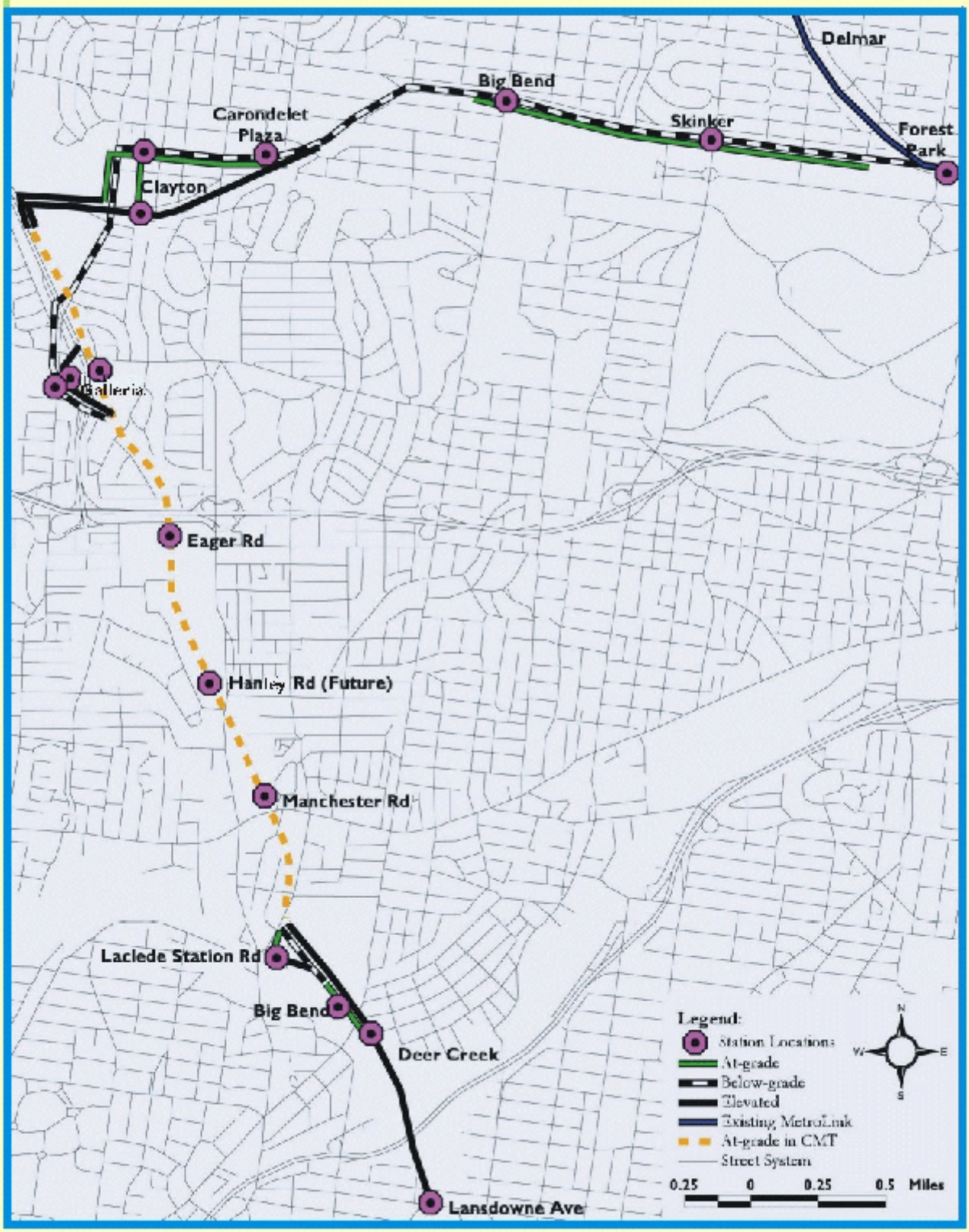
   The Carondelet Avenue underground concept simply continues to Brentwood Boulevard and then south to the Galleria Parkway and to the CMT right-of-way.

   Because of the problems with the Forsyth Boulevard location, the attractiveness of an at-grade alignment on Maryland Avenue is significantly reduced. An underground concept could be used for the Forsyth alignment (in downtown) to the Maryland Avenue route. But this is a significantly longer route than using Brentwood Boulevard. The latter could achieve equal operating qualities, but at lower cost compared to the Maryland Avenue route. For these reasons, Maryland Avenue is not recommended.

   At the Galleria, the recommended alternatives provide three options for the station - CMT right-of-way, elevated integrated with new development, and under Brentwood Boulevard.

3. The combination of candidate alternatives reflects a range of cost and performance using below grade, surface and elevated designs, including several horizontal alignments as well. Further design and analysis will illustrate the tradeoffs between performance, costs, benefits and impacts. This will present decision-makers with reasonable choices at the conclusion of conceptual design.

CANDIDATE ALTERNATIVES



CROSS-COUNTY METROLINK EXTENSION - SEGMENT 1