5. DEVELOPMENT OF CONCEPTUAL ALTERNATIVES

This study was conducted using a two-tiered analytical approach through which transit alternatives were developed in response to detailed study purpose criteria. The alternatives were tested and refined to ultimately select the alternative that best met the objectives of the study. Initially, the broadest range of possibilities was explored. Through subsequent levels of analysis, alternatives were dropped, refined, and combined with others to create a smaller set of alternatives with the best features of those previously tested. The resulting alternative, a composite of those initially tested, appears to best achieve the project's goals and is recommended as the locally preferred alternative (LPA).

Initially, the study area was evaluated to determine the portions most suitable for mass transit. Areas that could most benefit from higher capacity/higher speed transit and areas that could best support such transit were sought. Potentially transit-supportive areas, defined as those portions of the study area containing commercial, retail and high-density land uses, were highlighted. The study team then developed a series of transit alternatives that would serve the transit-supportive areas.

The first tier of study involved the creation of ten transit alternatives. The alignments were developed according to current and future forecasted land uses. An effort was made to connect as many transit-compatible areas (such as retail, high-density residential and commercial areas) as possible, since these areas would logically benefit from transit service and would generate ridership beyond the necessary threshold to support transit.

This chapter describes the process used and alternatives developed in the initial, conceptual alternatives development.

5.1 IDENTIFICATION OF TRANSIT-SUPPORTIVE DEVELOPMENT

An initial screening was performed to identify those portions of the entire study area that would be most appropriate for transit. The current zoning for the City and County portions of the study area were classified as transit-supportive based upon the following classifications:

- All parcels of land with commercial uses
- All parcels of land with townhouse, multiple family dwellings
- All parcels of land with light industrial uses

- The entirety of Potomac Yard (generally dedicated to higher density residential and commercial uses)

Figure 5-1 shows the areas classified as transit-supportive. The corridor of land surrounding the CSX and Metrorail tracks, including all of Potomac Yard and Crystal City, fall into this category. Other areas include:

- Pentagon City
- The Mount Vernon Avenue Corridor
- The area surrounding I-395 at South Glebe Road (Avalon at Virginia Square)
- Portions of Northeast Old Town.

Clearly, there is variation in the intensity of use in these areas and consequently, some variation in the extent to which any of these areas is likely to generate the ridership necessary to support a transit system. By using a liberal interpretation of "transit-supportive land uses" the intent is to exclude only those areas that are clearly insufficiently dense to support transit.

This initial analysis confirmed what was generally assumed—that only part of the study area would be appropriate for additional high quality transit. The U.S. Route 1 Corridor, Potomac Yard, and Crystal City are the areas containing the highest development densities and either exist or are planned to be the most transit-oriented. Consequently, the corridor of land extending from just west of U.S. Route 1 eastward to the CSXT railroad tracks, north of the Monroe Avenue Bridge, and as far east as Patrick Street in northeast Alexandria, from the Braddock Road to Pentagon Metrorail stations, became the focus for further study. Other areas, such as the Mount Vernon Avenue and Pentagon City might be served with feeder bus connections to the U.S. Route 1 trunk service.

5.2 DEVELOPMENT OF TIER 1 ALTERNATIVES

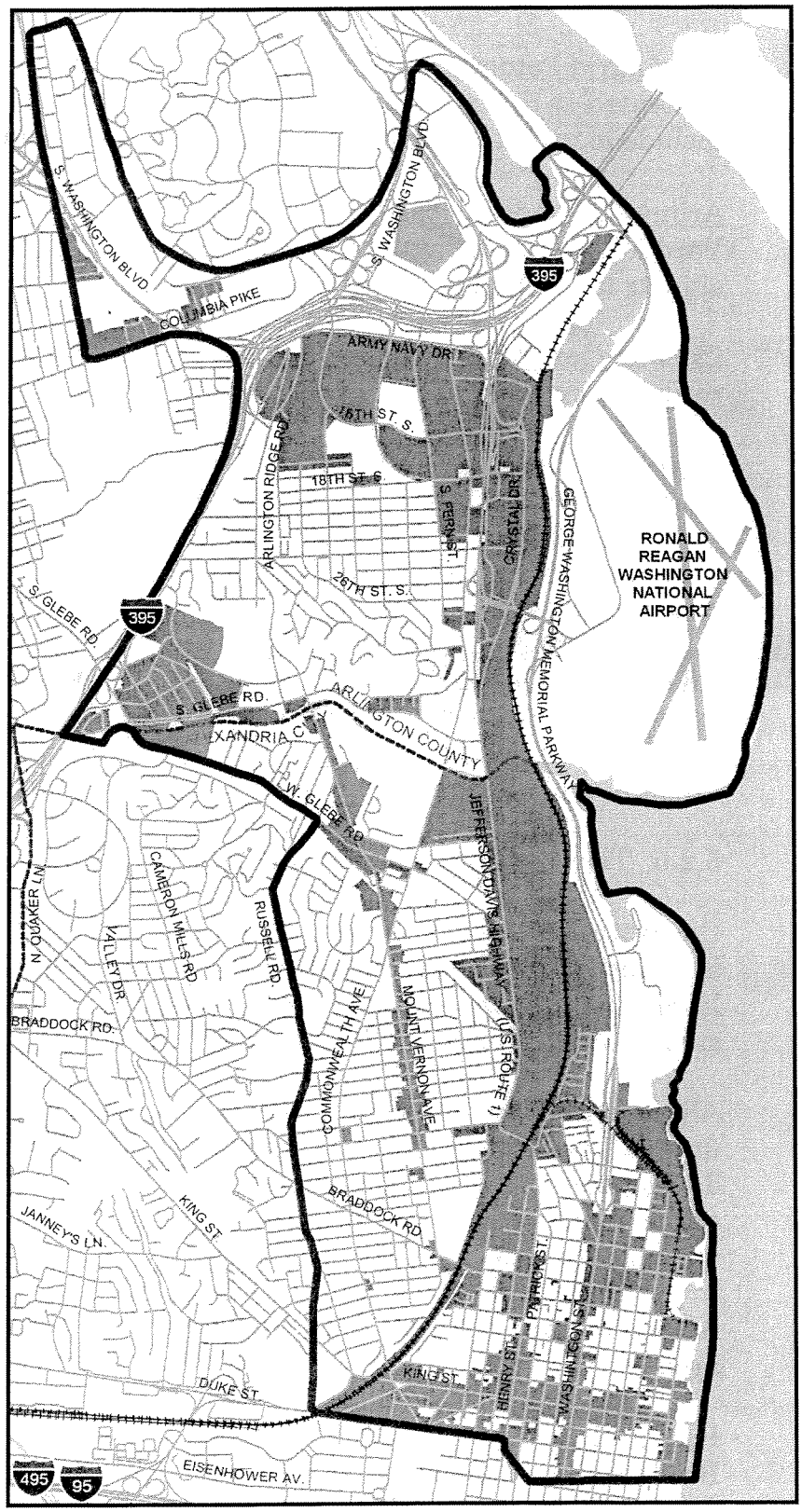
5.2.a. Tier 1—Study Zones

The study area was divided into five zones of generally homogeneous land use that offered potential transit routes along parallel paths. These zones are described below.

Braddock Road Metrorail station - This area includes the Metrorail station of the same name. The area currently includes low and upper-income housing,

Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig 5-1
TRANSIT-SUPPORTIVE
LAND USE IN THE
STUDY AREA



warehousing, and some office space. Future development includes increased office space.

Alexandria Potomac Yard - Much of the new development in the corridor will be located in this zone. The area currently contains a shopping center but will include more extensive retail, residential, and commercial development.

Arlington Potomac Yard South Tract – This area is the portion of Potomac Yard located in Arlington County. This area is slated for future development similar to the higher density development in current day Crystal City.

Crystal City/Pentagon City - A dense mixed-use area consisting of ten to twelve story buildings in an urban grid.

Arlington Potomac Yard North Tract– This zone contains the Arlington North Tract and the Pentagon reservation.

Figure 5-2 shows the alternatives development zones. Conceptual transit alignments were developed within each of the zones described above. Generally, alignments were located along: the east side of the zone; the west side of the zone; or the center of the zone. Given the rectilinear nature of the existing or proposed street system, alignments will logically remain along one of these generalized routes. Transitions from one side to another will most logically occur at the interface between the two zones.

5.2.b. Tier 1—Development Of Alternatives By Study Zone

Conceptual alternatives were developed in Tier 1 of this study by identifying alternatives within each of the five zones in the study corridor. At this initial level of alternatives development, mode was not considered. In subsequent steps the suitability of any given line to any given mode was considered.

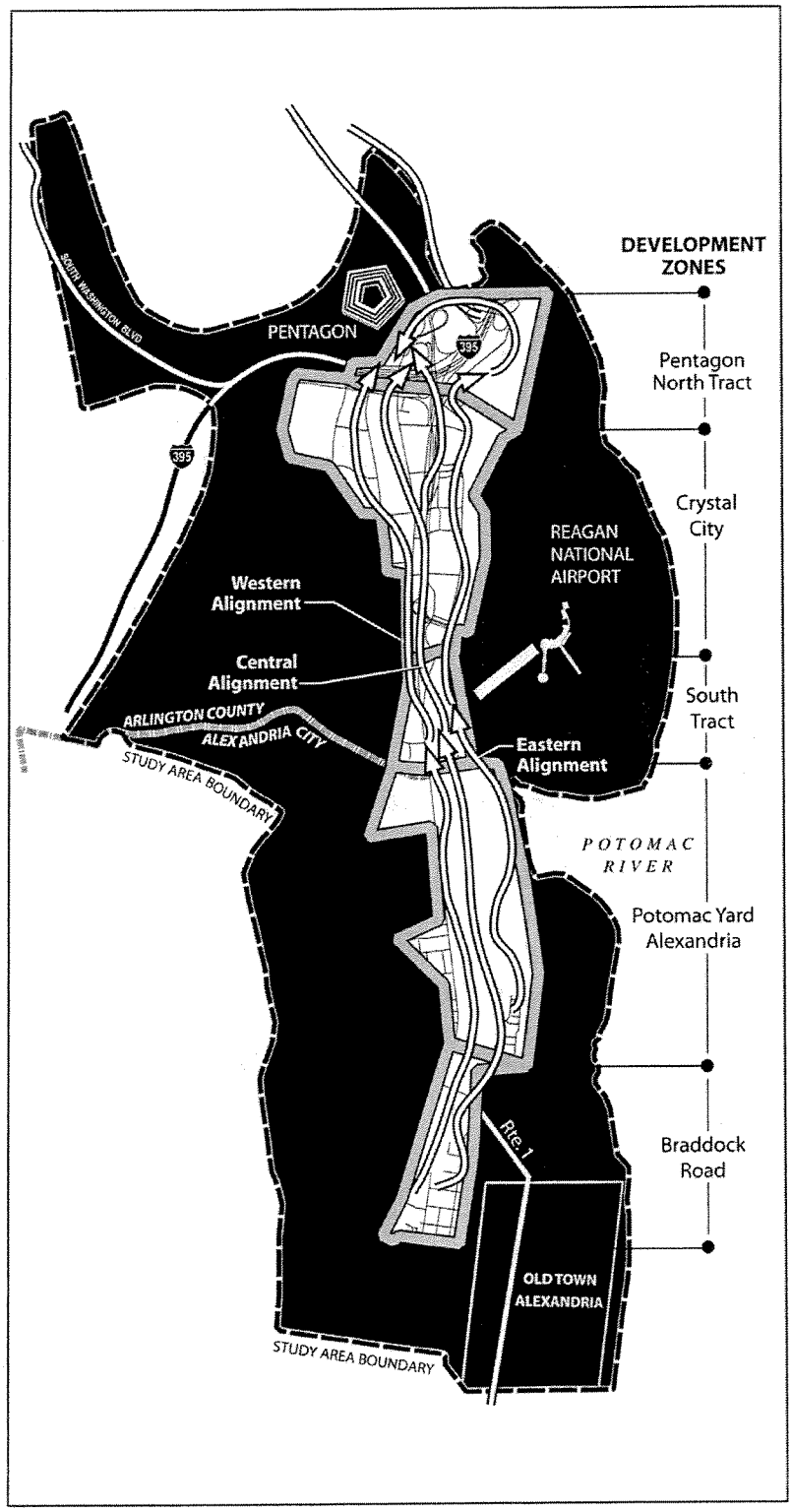
Alignments were placed across each of the development zones in as many unique locations as appeared to exist within each zone (Figure 5-2 shows the development zone and general routing of alternatives). Generally, a western, eastern, and central alignment seemed to cover the full range of possibilities within each zone.

A zone-by-zone review shows the specifics of this approach across the study area.

Potential Braddock Road Alignments - This area begins in the area of the Braddock Road Metrorail station and moves north to the present-day Monroe Avenue Bridge. Potential alignments could run along the proposed Main

Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig. 5-2
DEVELOPMENT ZONES
CONSIDERED IN
ALTERNATIVES ANALYSIS



Street, just west of the Metrorail station (western alignment); along or on U.S. Route 1 (central alignment); or along Powhatan Street (eastern alignment). (See Figure 5-3)

Potential Potomac Yard Alexandria Alignments - There are three potential alignments in this zone which starts at the Monroe Avenue Bridge and ends at the Arlington County border. U.S. Route 1, on the western side, is a route that could accommodate a transitway. This alignment would serve Del Ray residents, as well as the higher-density apartments that will face U.S. Route 1 from the Potomac Yard development. An eastern alignment was also considered along the entire length of the proposed Potomac Avenue. The study team concluded that a Metrorail alternative would need to run on the existing Metrorail line, and thus could only have an eastern alignment. A third alignment, running through the center of Potomac Yard, possibly in the vicinity of the proposed Main Street would also be possible. (See Figure 5-3).

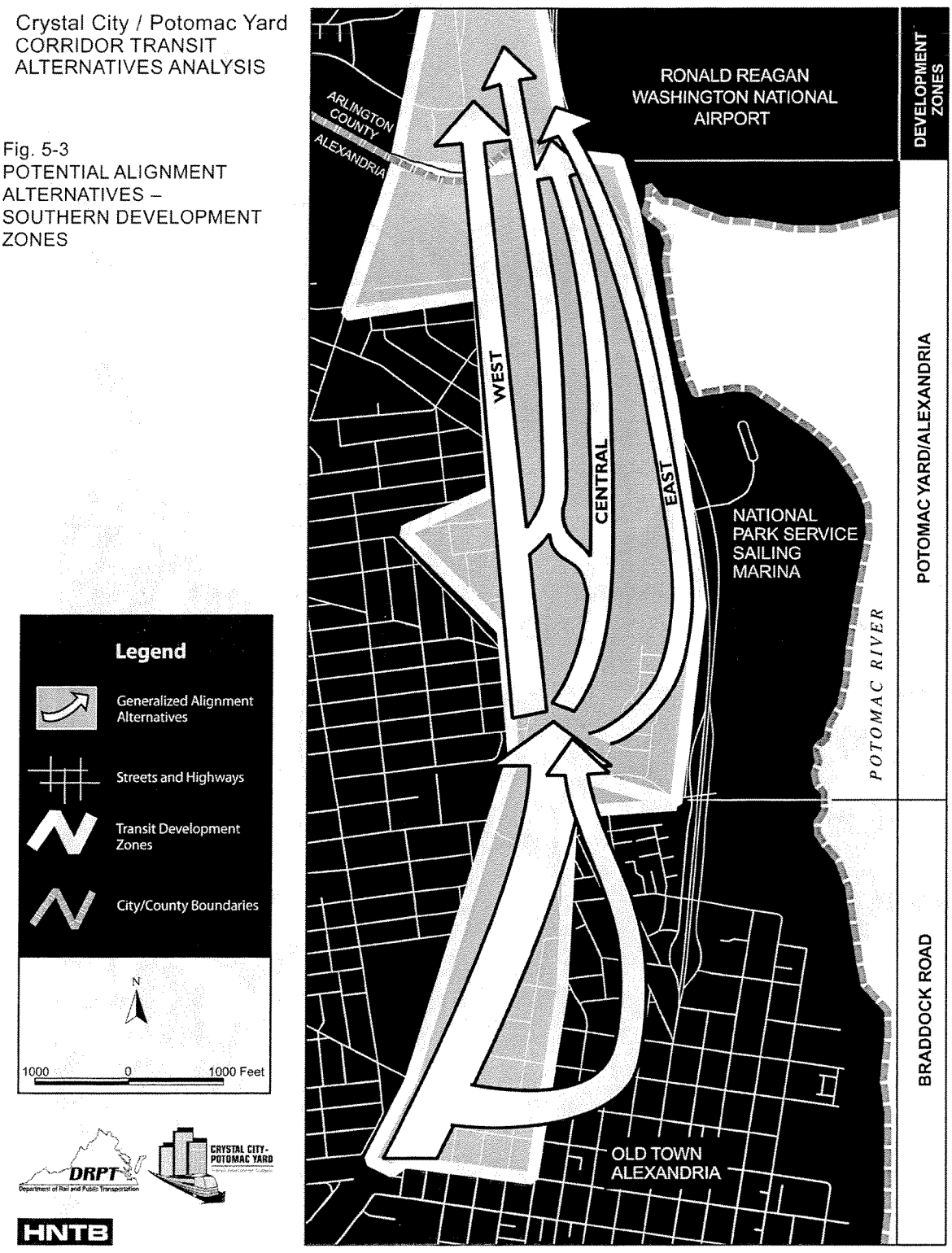
Potential Arlington South Tract Alignments - The Arlington South Tract zone starts in the south at Four-Mile Run and ends at about 27th Street South, where Crystal City begins. Prior to this study, Arlington County approved a transitway that would run along the proposed Potomac Avenue heading north, then turn west on an extended South Glebe Road, and then it would turn north onto Crystal Drive.

Three preliminary alternative alignments were developed by the Study Team independent of the approved Arlington transitway alignment. Proposed alignments included a western alignment that would move along U.S. Route 1 and an eastern alignment that would run along Potomac Avenue. The Study Team concluded, as with the Potomac Yard Alexandria zone, that the Metrorail option would serve as an eastern alignment. The third option, a central alignment would run on the proposed transitway through the middle of the development in this zone. Similar to the Main Street alignment in Alexandria, this option would run along small-scale shopping development. (See Figure 5-4)

Potential Crystal City Alignments - This section runs from 27th Street South to 12th Street South. The potential alignments in this zone would run along Crystal Drive (eastern alignment), Route 1/Clark Street (center alignment), and Eads Street (western alignment). Arlington County has also approved a transitway in this section, but at the time of this study, was studying whether that transitway should be on Crystal Drive or Clark Street. WMATA also used Clark Street as an alternative in its LRT/BRT study. Arlington County is also considering converting Crystal Drive from a one-way northbound street to a two-way street. Any alignment would need to be developed accordingly. (See Figure 5-4)

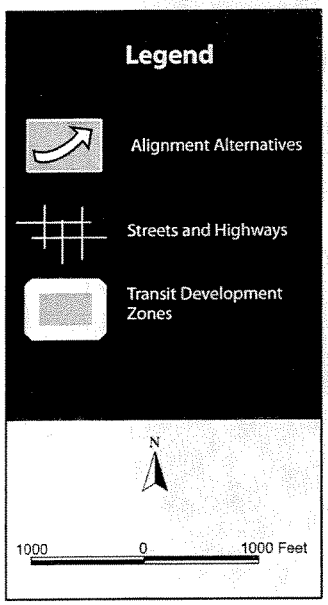
Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig. 5-3
POTENTIAL ALIGNMENT
ALTERNATIVES –
SOUTHERN DEVELOPMENT
ZONES



Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig. 5-4
POTENTIAL ALIGNMENT ALTERNATIVES – NORTHERN DEVELOPMENT ZONES



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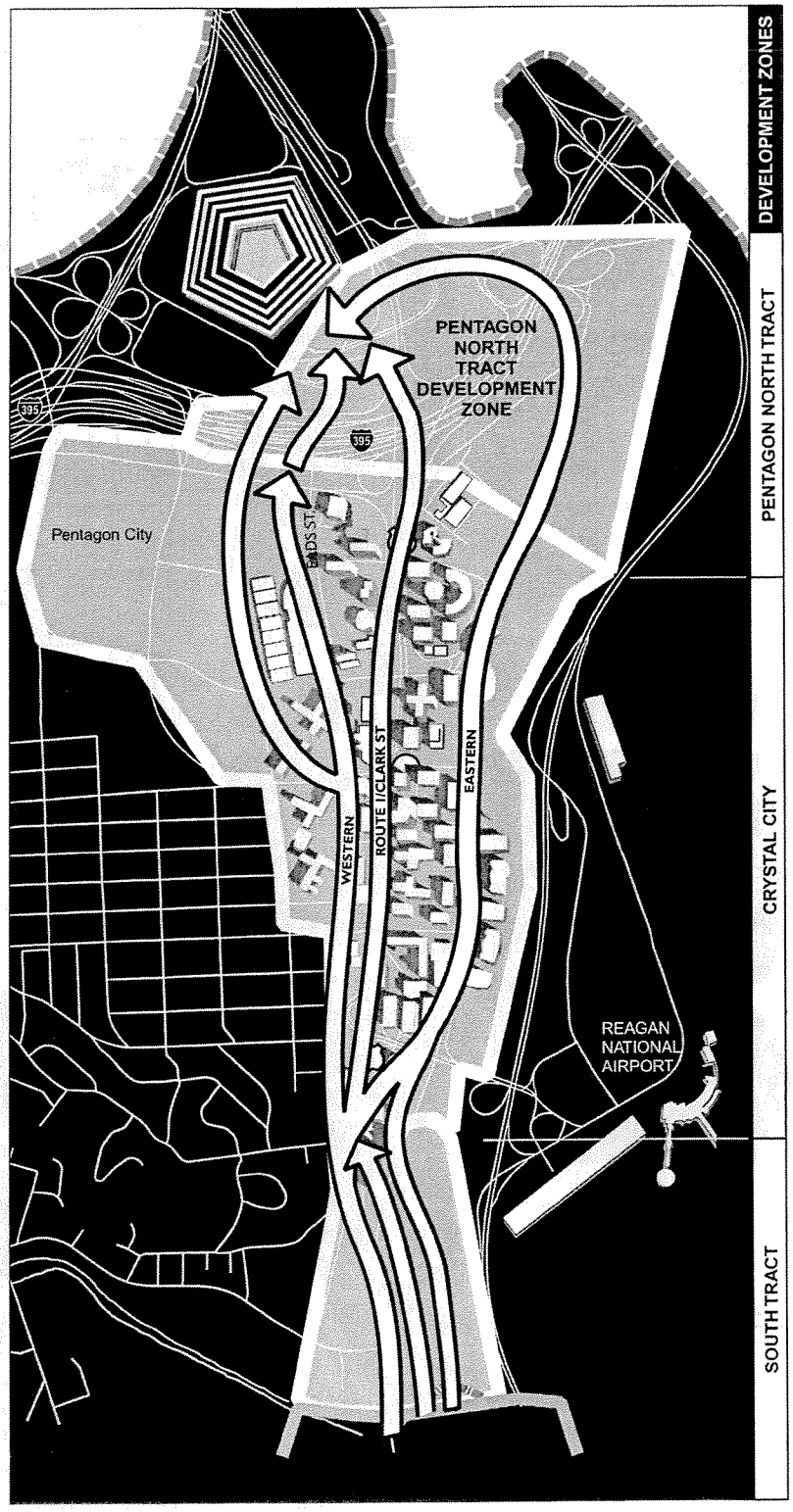

Potential North Tract Arlington/Pentagon Alignments - This section starts at 12th Street South, at the edge of Crystal City, and terminates at the Department of Defense headquarters. The Pentagon area has a Metrorail station and a terminal for buses commuting from Northern Virginia. For security reasons, the original terminal was replaced by a new terminal 500 feet away from the Pentagon building. The new Metro Entrance Facility, now referred to as the Pentagon Transit Center, has more amenities such as Metro sales office, bigger shelters, and more space.

The North Tract includes the open space along the Potomac River that has been slated for development. At the time of this study, the County did not know for certain what type of development would take place in this area, but it is assumed that the tract will be used for recreational purposes.

There is an eastern, western, and central alignment in this area. The eastern alignment runs more or less along Old Jefferson Davis Highway, serving the future uses of the North Tract. The western alignment runs along Eads Street in Crystal City. Eads terminates at the Pentagon. The central alignment would continue along the Route 1/Interstate 395 interchange. A bridge or tunnel would be required. (See Figure 5-4)

5.2.c. Tier 1—Description of Alternatives/Alignments

The study team created ten alternative alignments by combining the various alignment options within each geographical development zone discussed previously. Nine of the alignments could support either BRT or LRT. One alternative (with two stations) was selected solely as a Metrorail alternative. (Metrorail stations can only be placed along the existing Metrorail alignment in this corridor.)

Each of the linear alternatives starts at Braddock Road and moves north, terminating at the Pentagon. Figures 5-5a, 5-5b, and 5-5c show the alternative linear alignments. Figure 5-6 shows the Metrorail alternative.

Alignment A—Western Alignment - Commencing from the south, this alignment runs along Main Street and then shifts to Route 1 around the Monroe Avenue Bridge. The alignment continues on Route 1 until just north of 32nd Street, where the line moves to Eads Street. The route makes a one-way loop through the Pentagon grounds.

Alignment B—Eastern Alignment - This alignment starts along Main Street and continues on Main Street to just south of the Town Center. At the Center, the alignment turns left on an east-west street (Calvert or Raymond Street) then turns north to join Potomac Avenue. After Four-Mile Run, the

Crystal City / Potomac Yard
CORRIDOR TRANSIT
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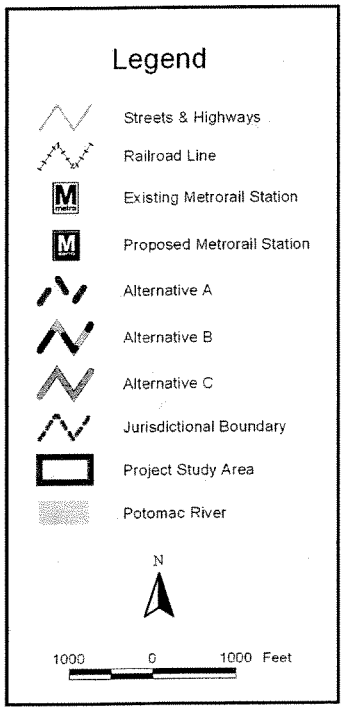
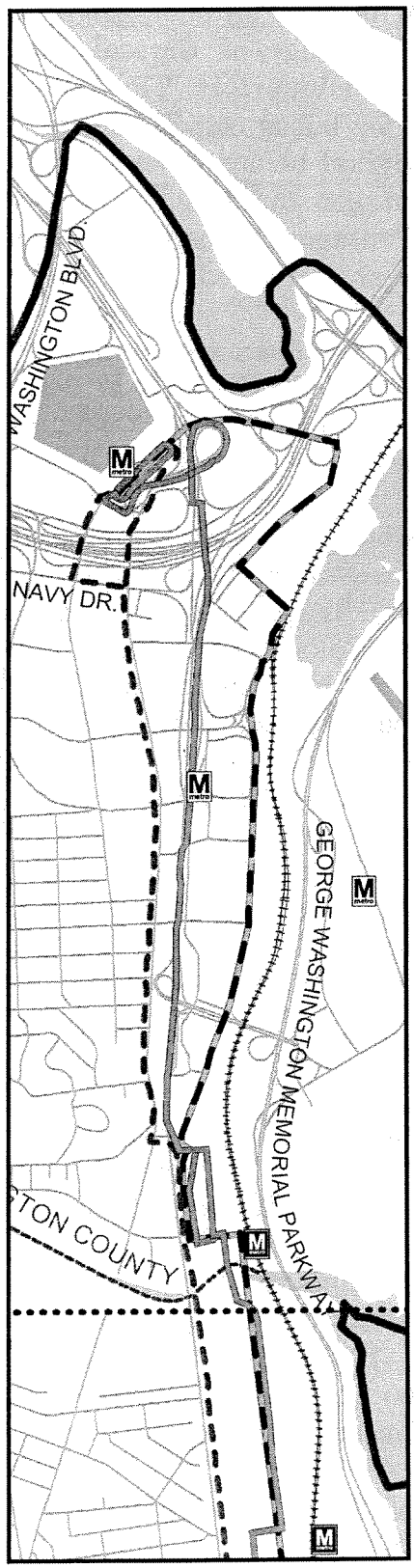
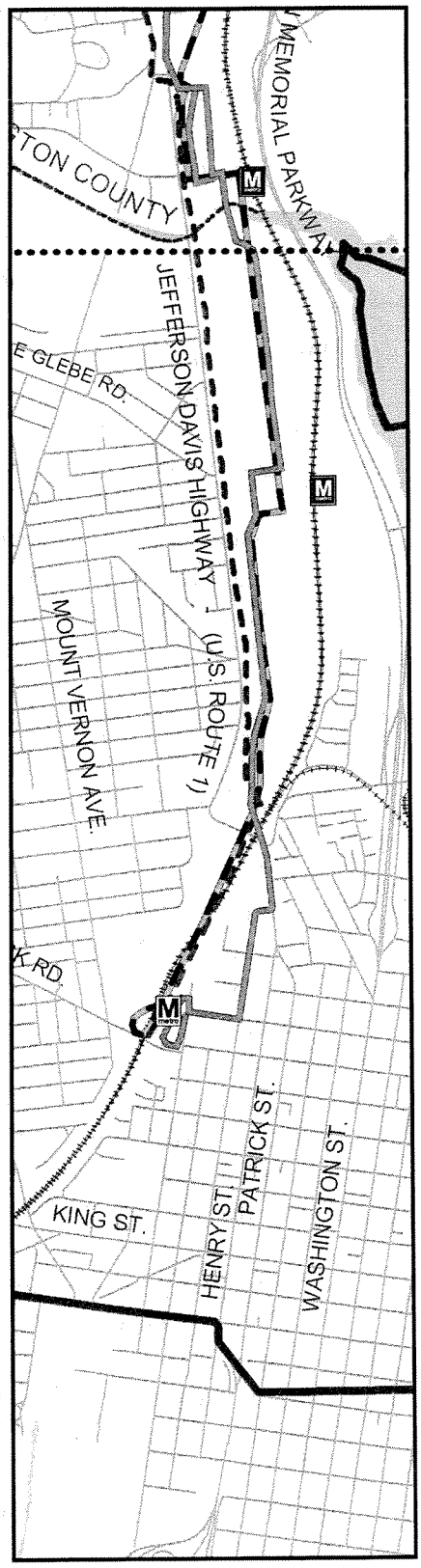
Fig 5-5a
TIER 1
BRT/LRT ALTERNATIVES

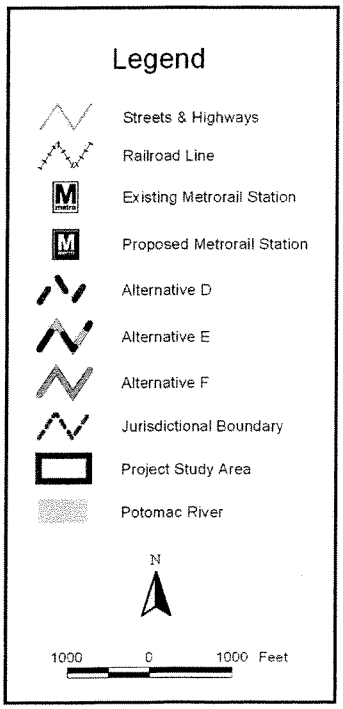


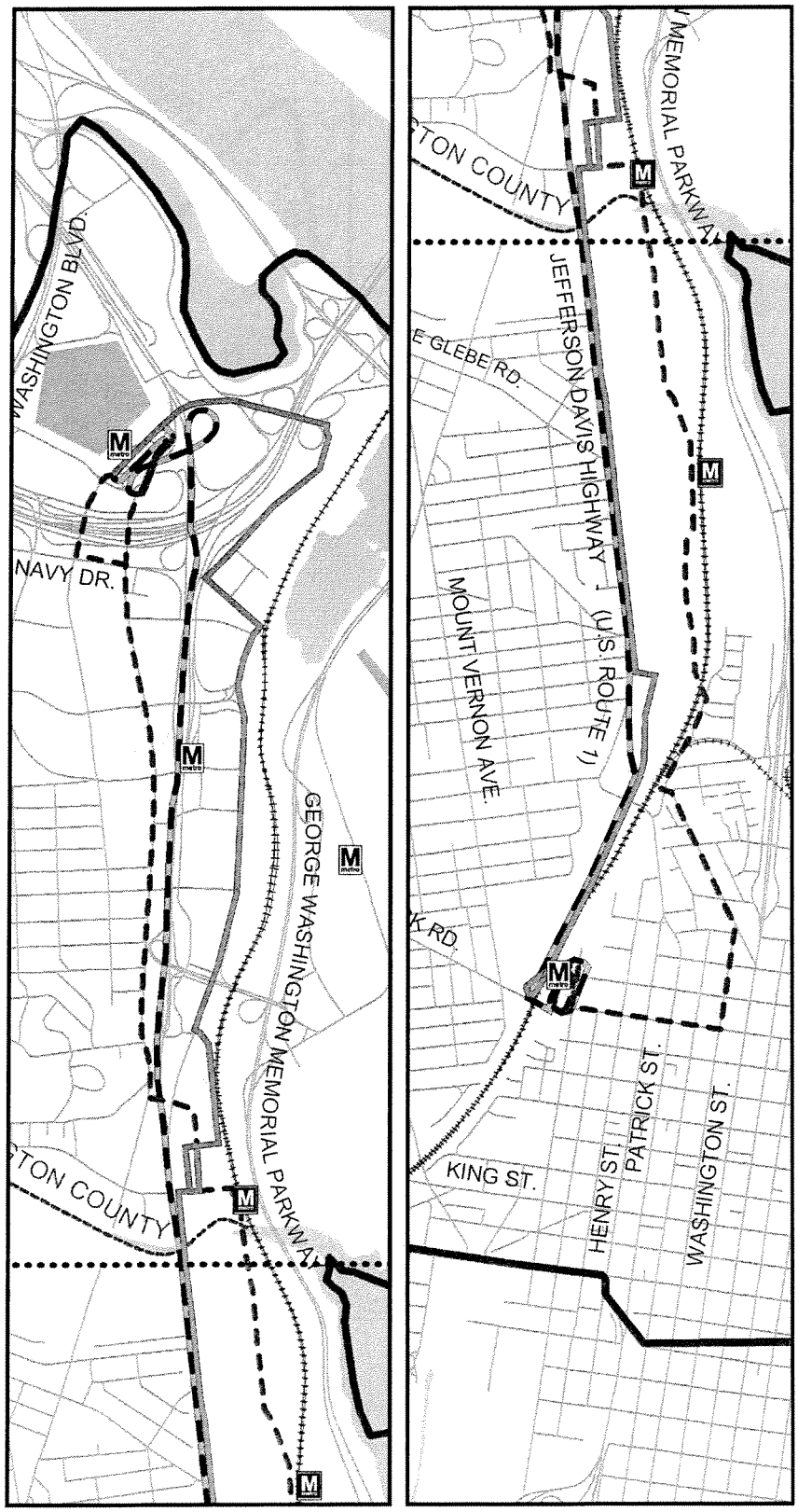




Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig 5-5b
TIER 1
BRT/LRT ALTERNATIVES





Crystal City / Potomac Yard
CORRIDOR TRANSIT
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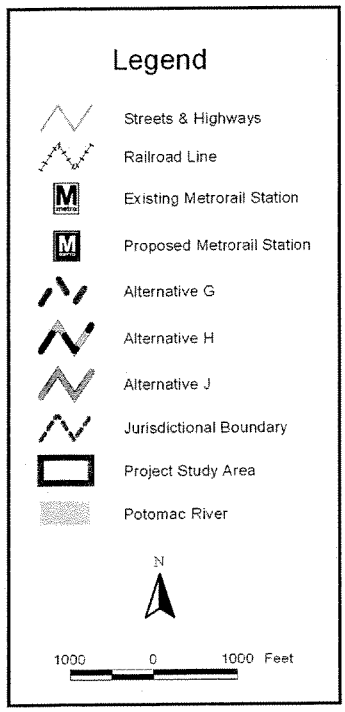
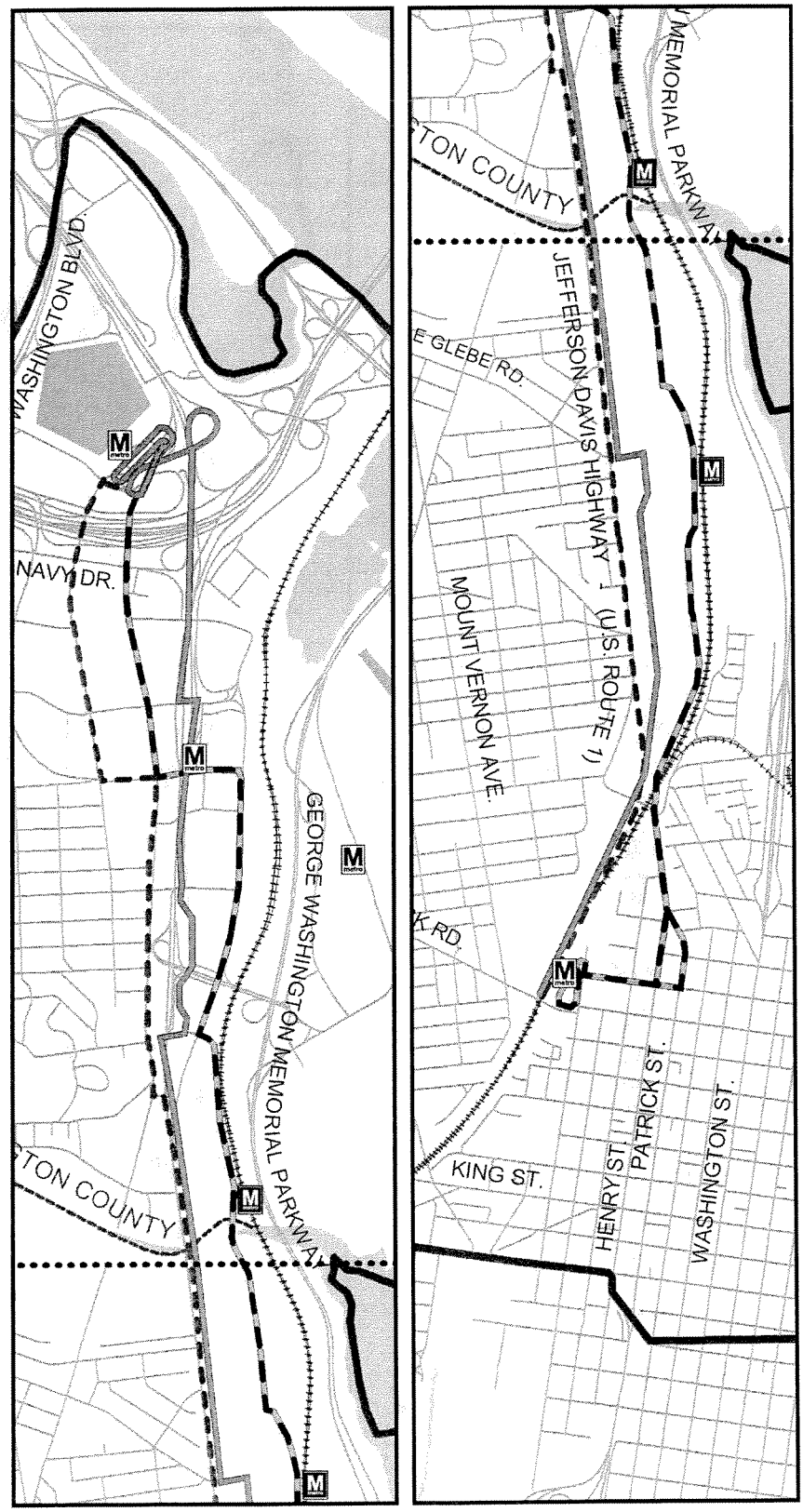
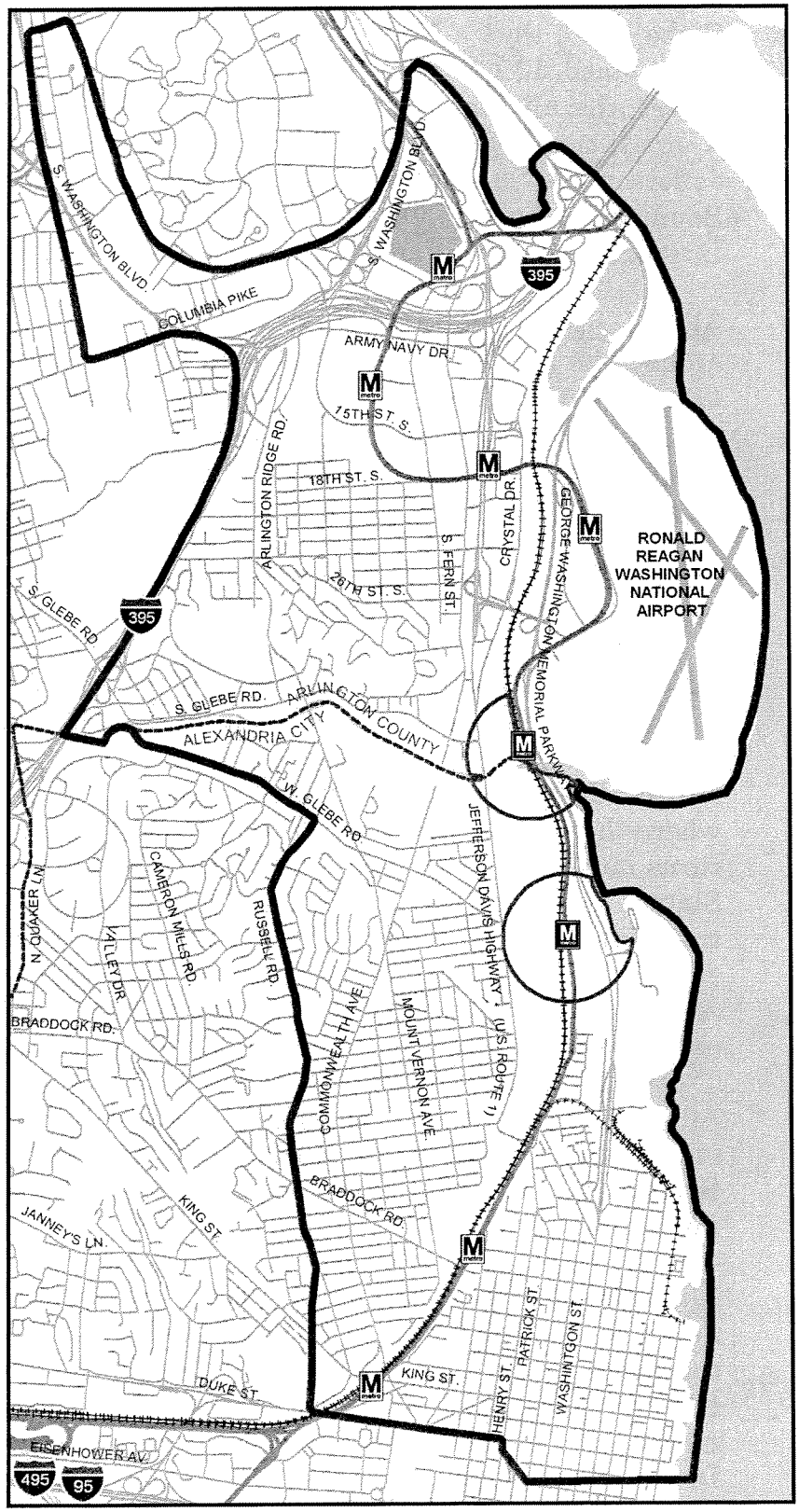
Fig 5-5c
TIER 1
BRT/LRT ALTERNATIVES





Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig 5-6
TIER 1
METRORAIL ALTERNATIVES



Legend

- Streets & Highways
- Railroad Line
- Existing Metrorail Line
- 1/4 Mile Buffer of Proposed Metrorail Station
- Existing Metrorail Station
- Proposed Metrorail Station
- Jurisdictional Boundary
- Project Study Area
- Potomac River

N

1000 0 1000 2000 Feet

DRPT Department of Rail and Public Transportation

CRYSTAL CITY-POTOMAC YARD

HNTB

alignment follows the Arlington transitway proposal taking a left on South Glebe Road, then a North on Crystal Drive. The alignment stays on Crystal Drive until 12th Street. When Crystal Drive turns west and becomes 12th Street, the alignment continues north until it is perpendicular to 6th Street where it turns west and moves along 6th. The route then turns north on Old Jefferson Davis Highway through the North Tract, and turns west on Boundary Channel Drive. The alignment would then maneuver under Interstate 395 and over Route 110 via a new bridge to the Pentagon.

Alignment C—Central Alignment - This alignment starts with a loop track around the Braddock Road Metrorail station, then proceeds east on Madison to northbound Fayette Street. The alignment then makes a turn northbound to North Henry Street (U.S. Route 1). After crossing the new straightened bridge, the alignment moves onto Main Street in Potomac Yard until it reaches the shopping center. At that point, the alignment shifts over to Potomac Avenue and continues to Four-Mile Run. The alignment splits in a one-pair down the center of the Arlington South Tract, then shifts over to Route 1 and continues along Route 1 until it reaches the Pentagon.

Alignment D—East to West Alignment - This option was meant to bring more service to the residential community in Old Town Alexandria and Crystal City. The alternative starts with a loop track at the Braddock Road Metrorail Station, then continues west on Wythe Street-Parker Gray Lane, where the route turns north on Columbus Street. From Columbus, the route turns northwest onto Powhatan Street. At the intersection of Powhatan and Slaters Lane, the alignment turns north along the eastern side of the CSX train line until it reaches the Potomac Greens residences. The alignment crosses the CSX and Metrorail lines and continues north along Potomac Avenue.[2] The alignment goes through the center of Arlington South Tract and then crosses over to Eads Street.

Alignment E—West to Central Alignment - This alignment is among the most direct. It starts on Main Street, continues to the Monroe Avenue Bridge, then shifts to U.S. Route 1 and remains on it until it reaches the Pentagon.

Alignment F—West to East Alignment - This alignment starts along Main Street, and then shifts to U.S. Route 1 at the Monroe Avenue Bridge. It continues along U.S. Route 1 until South Glebe Road, where it turns east, then north through the center of the Arlington South Tract for a brief moment. The alignment moves onto Potomac Avenue and then Crystal Drive. From there, the alignment moves off of Crystal Drive to 10th Street, then north on Old Jefferson Davis Highway. The alignment makes a turn

[2] Further study would be required to determine how the alignment would cross the rail lines.

west onto Boundary Channel Drive before crossing over Virginia Route 110 to the Pentagon.

Alignment G—Western Alignment - This alignment is similar to the Western alignment as it passes through the Alexandria Section of the study area. In this alignment, the route goes west on 18th Street, and then north on South Fern Street. It enters the Pentagon from South Fern Street and terminates at the Pentagon.

Alignment H—East to West Alignment - This alignment goes east along Madison to U.S. Route 1 (a one-way pair comprised of Patrick and Henry Streets) where the alignment splits and continues on Route 1 to Potomac Avenue. Once on Potomac Avenue, it remains there until it intersects Crystal Drive. The alignment turns north on Crystal Drive and continues until 18th Street. Via 18th Street, the alignment crosses over to Eads Street. The alignment stays on Eads until it reaches the Pentagon.

Alignment J—Central to Clark Street Alignment - This alignment starts along Main Street and continues to the Potomac Yard Shopping Center. Via East Glebe Road, the alignment moves to U.S. Route 1 where it remains until 27th Street South. The alignment then moves to South Clark Street. It continues along Clark until 15th Street, where it moves onto U.S. Route 1 and then continues along U.S. Route 1 to the Pentagon.

Alignment K—Eastern Alignment (Metrorail) – This eastern alignment was developed as a Metrorail alternative. The existing Metrorail line, with the inclusion of new stations, would serve the same area as an alignment along the entire length of Potomac Avenue.

The Metrorail "alignment" includes the construction of either one or two stations in the corridor along the existing Metrorail tracks. Two stations, one at Potomac Yard and one at Four Mile Run, have been studied in the past. WMATA has done some preliminary studies on the costing and design of such stations[3], and Commonwealth Atlantic Properties has set aside land for a future station. Crescent Properties, the current developer, has kept the land available.

The Four Mile Run station would be located at the end of the expanded South Glebe Road in the Arlington South Tract. The station would provide access to the retail venues and residences in South Tract.

[3] Washington Metropolitan Area Transit Authority (Department of Transit System Development), *Alexandria/Arlington-Potomac Yard In-fill Station Study,* July 1999.

The Potomac Yard station would be located near the intersection of East Glebe Road and Potomac Avenue. The station would have a pedestrian walkway connecting both Potomac Yard and Potomac Greens (the residences across the tracks from Potomac Yard) to the station. This station would also provide access between Potomac Yard and Potomac Greens, encouraging more pedestrian and bike travel between the two neighborhoods.

5.3 FEEDER BUS NETWORK

While the high quality, high capacity alternatives described above serves the Route 1 Corridor, the intent of this project is to serve the entire Crystal City/Potomac Yard study area as described in Chapter 3. To provide 15-minute headways throughout the study area, each alternative would have a corresponding feeder bus network. *Coverage* for the purposes of this study is defined as transit service within a one-quarter mile of existing and proposed transit lines. A quarter-mile from any north-south transit line would offer coverage of less than half of the study area. A Metrorail alternative would offer even less coverage.

For the purposes of this study, the Study Team created routes that would supplement the current route system by WMATA, ART, DASH, et cetera. The routes created for this study were used solely for the purpose of "filling the gaps" of the current service. The feeder bus network is shown in Appendix D.

Were a transit alternative advanced for implementation the entire bus route structure passing through the study area would need to be revised. Responsibility for operation of the service would be determined subsequent to this study. Generally, bus operations that serve more than one jurisdiction are the responsibility of WMATA although there are numerous exceptions. For the purposes of this study, all supplemental bus service was assumed to be included as part of the proposed transit for the corridor and its costs allocated in accordance with the current Metro Compact funding formula. These assumptions were made for planning purposes only and are not intended to suggest a policy decision.

6. TIER 1—ALTERNATIVES EVALUATION

The initial, or Tier 1 analysis, was intended to identify the alignment segments that had the greatest potential to meet the goals and objectives described in the project's Purpose and Need Statement. The Purpose and Need Statement was ultimately used to develop a series of eight evaluation criteria, however this initial Tier 1 screening used coarser measures more suitable to the more conceptual nature of the alternatives at this early stage in the study.

6.1 TIER 1— EVALUATION CRITERIA

Three primary factors were used to distinguish between the alternative alignments segments within each zone of the study area. These are:

- Ridership potential: Using the 2025 Version 2 travel demand forecast model dataset, the forecasted number of trip-ends (the total number of all trips originating or destined) within one-quarter mile of potential station locations was determined. While trip-ends do not reflect the future ridership, as not all trip-ends will convert to transit trips on the proposed system, the measure does offer a relative measure of the potential of a transit alignment to generate ridership.

- Transit-supportive land use: Typically, transit ridership is greatest when transit serves areas of commercial, office, retail, and high-density residential land uses. Each alignment segment was evaluated based upon the length of "transit-supportive" land that it passed.

- Noise-sensitive areas: Generally, residential land uses, particularly low-rise residential buildings, are most sensitive to noise generated by transit or other modes of transportation. Each alignment segment was evaluated to determine the extent to which it would pass through residential areas. For purposes of this study, it was assumed that future residential buildings constructed in Potomac Yard would be of a design that would mitigate transit noise consistent with the desire to create transit-oriented development.

6.1.a. Ridership Potential

Transit potential, that is the number of trip ends within one-quarter mile of potential station locations, was plotted on Figure 6-1. The relative potential for a station to attract ridership can be observed by comparing the potential ridership moving east and west across the various alignments.

In the Braddock Road section of the study area, for example, it can be noted that the greatest potential is produced with alignments further to the east and away from the Metrorail line. In the vicinity of the Braddock Road Metrorail, ridership potential is approximately 47,000 to 49,000. West of the Metrorail line, ridership potential is approximately 45,000. While east of the station, east of Route 1, it exceeds 59,000. This analysis suggests that routes east of the Metrorail line would produce more ridership than those closer to or west of the Metrorail line.

In the vicinity of the Monroe Avenue Bridge, greater ridership potential is generated along Route 1 than is generated further east, along the Metrorail Line. Moving northward, through Potomac Yard, the greatest ridership potential is generated by stations lying along the future Main Street. Alternatively, the alignments along Route 1 produce slightly lower ridership potential. In this segment, the alignments further east, along the Metrorail line produce the lowest ridership potential.

The relationship between the alternative lines continues in the vicinity of the retail center. The routes closest to Route 1 tend to generate higher ridership potential than those behind the retail center. The differences however, are not dramatic.

Within the Arlington South Tract of Potomac Yard, no clear patterns emerge. While the alignments to the east show higher ridership potential than those to the west, some of those differences can be attributed to the position of the proposed stations on a north-south axis through the tract.

Ridership potential within Crystal City varies from south to north. On the southern end of Crystal City, higher potential can be observed to the east, along Crystal Drive. In the center of the area, Clark Street and Route 1 alignments produce higher ridership potential. North of 18th Street South, the highest ridership potential is generated along Eads Street, presumably because of the proximity to parts of Pentagon City. From the central portion of Crystal City and continuing on into the North Tract, the Crystal Drive and eastern alignments produce significantly lower ridership potential than the more western routes. The lower potential is based upon a relatively low level

Crystal City / Potomac Yard
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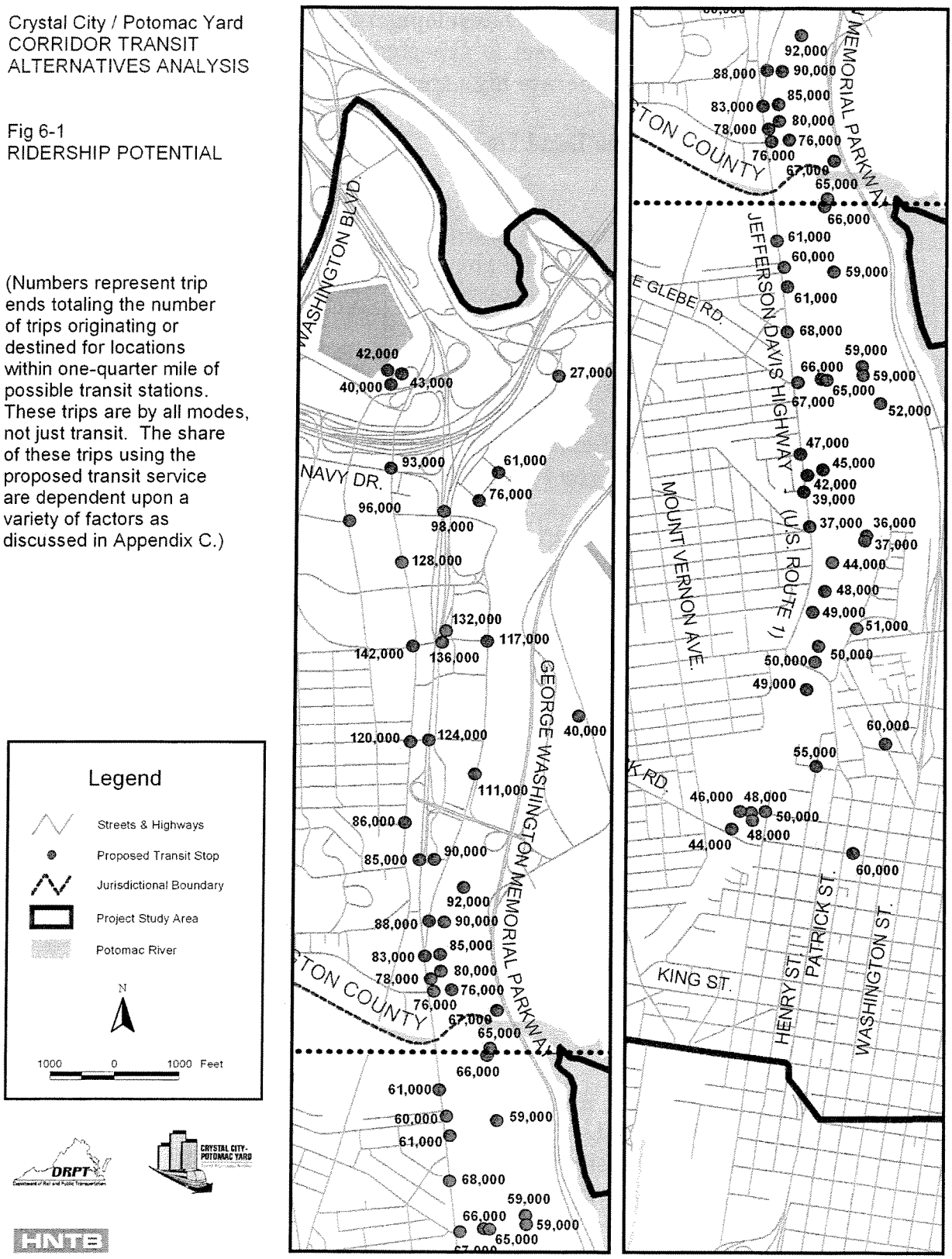
Fig 6-1
RIDERSHIP POTENTIAL

(Numbers represent trip ends totaling the number of trips originating or destined for locations within one-quarter mile of possible transit stations. These trips are by all modes, not just transit. The share of these trips using the proposed transit service are dependent upon a variety of factors as discussed in Appendix C.)



of development currently envisioned for the North Tract. While some office (and perhaps a recreation center) development is anticipated near 12th Street South, much of the North Tract is expected to be redeveloped as recreation fields, which would not generate high transit ridership.

6.1.b. Transit-Supportive Land Use

Examining the proximity of transit-supportive land use to the various alternative transit alignments offers additional guidance as to the more desirable alignments. Figure 6-2 shows the areas that contain land use most supportive of transit. The westernmost alternatives pass through transit-supportive areas over the entire length of the southern end of the study area. At Route 1, crossing the Metrorail line, transit-oriented residential and retail development is planned. East of the Metrorail line, only a few tracks of transit-oriented development exist. Consequently, within this section of the overall alignment, the alignments west of the Metrorail line are more transit-supportive than those to the east.

North of the Monroe Avenue Bridge, all of the alternative alignments pass through what will be transit-oriented development. Potomac Yard is being developed in a transit-supportive fashion and most of the property west of Route 1 will be transit-oriented. The current development immediately facing Route 1 on the west is generally light industrial, but is expected to be redeveloped in the future.

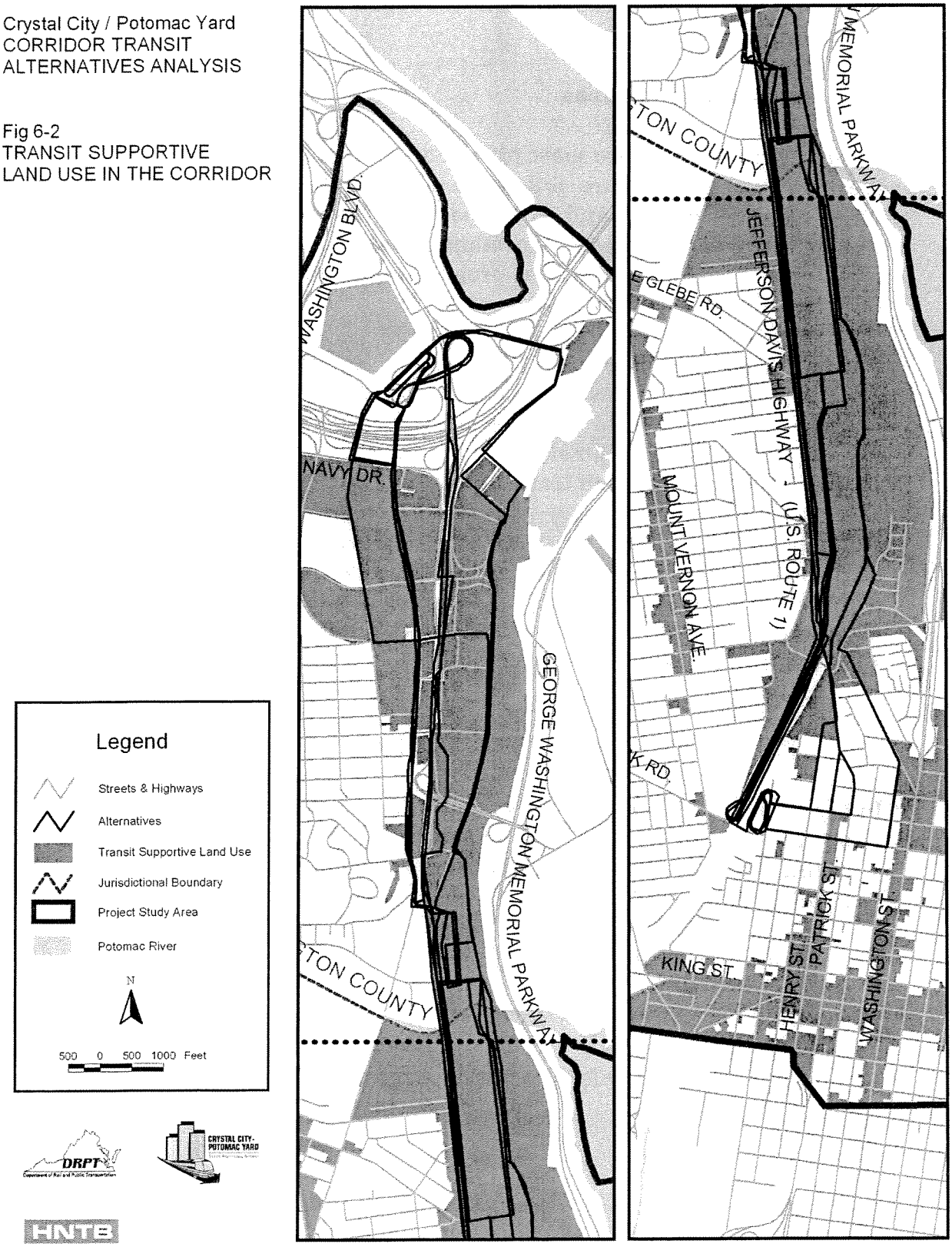
On the northern end of Potomac Yard, within Alexandria, all of the alignments pass through transit-oriented development. However, some of the land uses on the west side of Route 1 are industrial and therefore not transit-oriented.

Similarly, all of the alignments through the South Tract and into Crystal City traverse transit-oriented development. Only the parcel on which the Pentagon Centre shopping area is located is not transit-oriented. Our analysis of transit-oriented land uses were dependant on zoning classification. Since the area is zoned light industrial, it was assumed that the present land use will not be transit-oriented over the long term.

North of Pentagon City, none of the land through which the alternatives pass is truly transit-oriented. Both the Pentagon Reservation and North Tract cannot be called transit-oriented, although the building itself generates among the highest transit mode shares in the Washington region.

Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig 6-2
TRANSIT SUPPORTIVE
LAND USE IN THE CORRIDOR



In general, only minor differences in transit supportive land use distinguish the alternatives, but these differences suggest that some alternatives should not be pursued further.

6.1.c. Noise-sensitive Areas

Noise-sensitive areas are most prevalent in the southern section of the study area as shown in Figure 6-3. The alignments along Patrick and Henry Streets are residential and would be most adversely affected by noise from transit along these streets. In addition, the land south of Madison Street contains street-level residential property, and therefore is sensitive to noise from transit.

Within the Alexandria portion of Potomac Yard, much of the land south of the retail center will be developed as residential property. While this would ordinarily be expected to be noise-sensitive, because of the desire to create a transit-oriented development, it is expected that the homes will be sufficiently insulated from transit noise.

North of the retail center is a mix of commercial and residential properties. High-rise residential development is generally not considered noise-sensitive and so there are no significant noise-sensitive areas in the northern half of the study area. The extent of any noise impacts would be determined in subsequent studies.

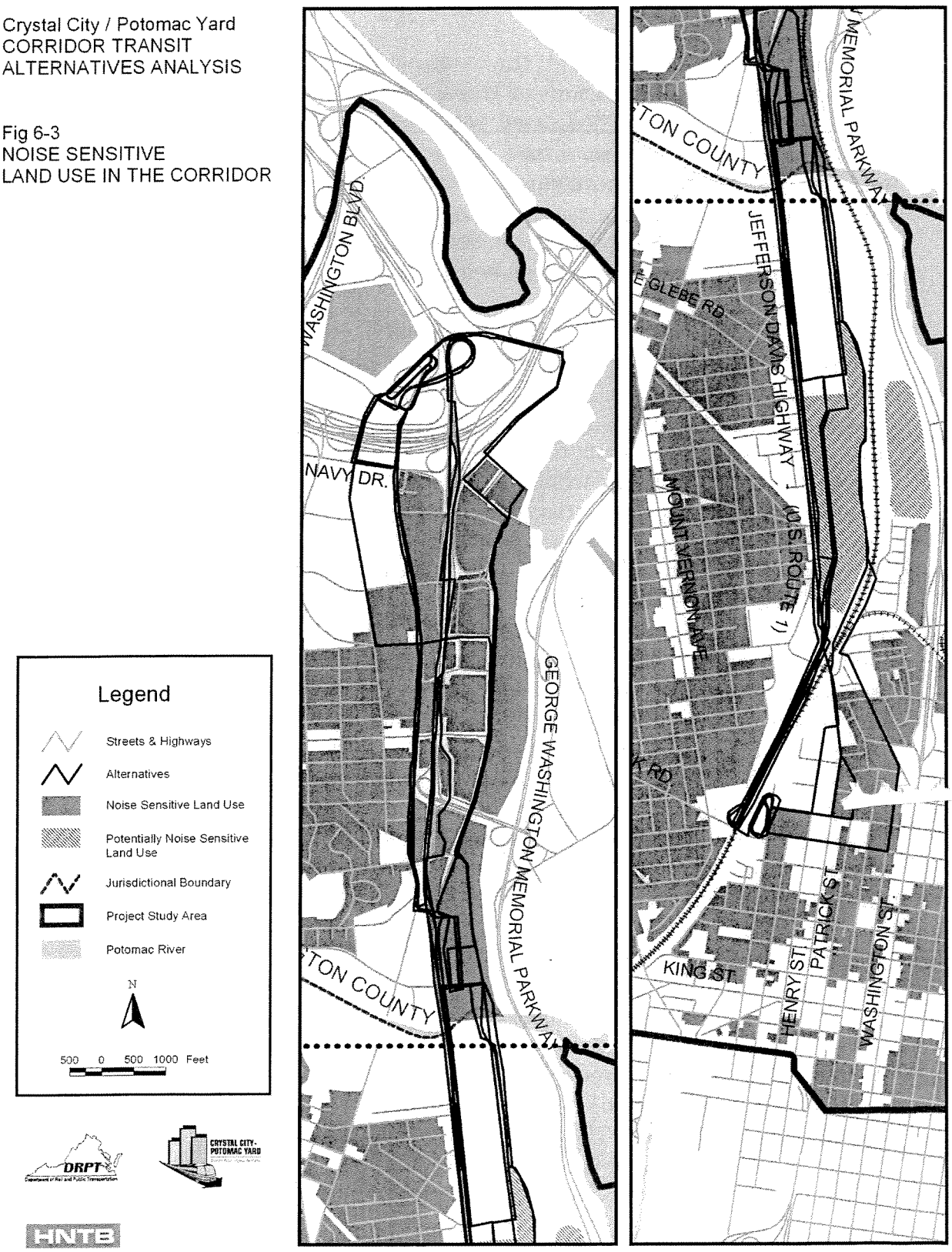
6.2 TIER 1 - ADDITIONAL EVALUATION CONSIDERATIONS

In the course of evaluating the various alternatives, several additional issues arose that were used to further assess the alternative alignments. The following were not formal criteria used in the Tier 1 Evaluation, but were a part of the Tier 1 analysis.

- Traffic engineering issues
- Congestion avoidance
- Quality of life
- Physical obstacles
- Department of Defense security issues.

Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig 6-3
NOISE SENSITIVE
LAND USE IN THE CORRIDOR



6.2.a. Traffic Engineering Issues

Running BRT or LRT through the existing and proposed streets of the study area will require modifications of lanes, signals, and general operations. BRT and LRT would run on dedicated roadways or lanes, but in some instances would need to operate in mixed traffic. Special design features would be necessary to facilitate more rapid movement through the study area so as to give transit passengers a time advantage over existing transit operations or even general automobile traffic. Several potential engineering difficulties were identified and are discussed below.

South Main Street - South Main Street, between Braddock Road and Monroe Avenue, has been planned as a narrow street. Between Braddock Road and the George Washington School, Main Street is planned as a narrow, local access street. A cul-de-sac near the school would permit traffic to turn around. Discussion about the street suggested that portions of it might be one-way only. Parking would be permitted along one side of the street. Generally, this type of arrangement would not be desirable for transit operations. While the Potomac Yard development plan anticipates transit on this street, that transit might be more on the order of DASH or other smaller transit vehicles operating neighborhood service rather than larger BRT or LRT line haul operations. In addition, analysis performed by the City of Alexandria staff indicated significant problems with extending the street to Braddock Road and permitting transit vehicles to exit southward and turn left (eastward) onto Braddock Road. Consequently, transit passengers would have to exit on the west-side of the Metrorail tracks and then walk through a tunnel or over an overpass to reach the Braddock Road Metrorail station. Plans prepared in June of 2001 proposed a reconfiguration of the intersection of South Main Street with Braddock Road. Under this plan, southbound transit vehicles would be able to turn left onto eastbound Braddock Road and then to access the Braddock Road Metrorail Station. The vehicles would then continue north on the local streets east of the Metrorail tracks, forming a one-way loop. Such a configuration is not usually considered desirable for transit operations and would not be preferred for use by a trunk service as envisioned under current project.

Main Street - Main Street, north of Monroe Avenue and extending to the southern end of the retail center, is planned as a narrow two-lane street, with parking on both sides. The street is intended to resemble King Street in Old Town and consequently is not ideal for higher capacity, higher speed transit service.

South Tract Transitway - The Phased Development and Site Plan (PDSD) for the South Tract identifies a corridor for a transitway. This two-lane wide

area would adequately support transit through the area and is preferable to other potential routes.

Clark Street - Clark Street currently serves as a southbound only street offering local access to properties facing Jefferson Davis Highway. Both parallel and ninety-degree parking are permitted along portions of this road. Sidewalks vary in width but in some places are rather narrow. Use of this street is predicated on the idea that Crystal Drive will be converted from a northbound only street to a two-way street. Changes in use and configuration of parking would be required for transit to operate effectively.

Crystal Drive - Crystal Drive is currently three-to-four lanes of northbound only traffic. Sidewalks vary in width. Transit could operate on this street but would require special accommodation to permit two-way transit on a one-way street or to permit conversion to two-way operation.

Eads Street, 12th Street South - These streets are two-way, two-lane in each direction. Each would require special configuration, signing, marking, and signals to accommodate transit. Transit alternatives that turn onto or off of these streets would need special treatment to pick-up and discharge passengers and clear signalized intersections.

Obtaining land for a dedicated guideway is problematic in some parts of the study area. Crystal City, for example, is a heavily developed area. An independent alignment going along Jefferson Davis Highway (Route 1) could only be achieved by constructing an aerial structure for truly independent operation. Alternatively, at-grade crossings would require special signalization that would favor transit over general traffic.

6.2.b. Congestion Avoidance

When considering the alternative transit modes, consideration should be made for the relative impacts on the future street traffic. A system, which shares general carriageway and/or utilizes space that could otherwise be dedicated as carriageway, may exacerbate problems of congestion on those streets.

Transit Signal Priority - Transit signal priority would be required for either BRT or LRT over most of the length of the study area. BRT/LRT vehicles would be equipped to transmit their presence to upcoming signalized intersections. Using a variety of possible timing and phasing plans, the signals would accommodate the transit vehicles' needs. Giving additional "green time" to the BRT/LRT vehicles would take time from general traffic. Consequently, general traffic could experience increased congestion. This

would be expected to be a potential problem at the cross streets within Crystal City (e.g., 23rd Street South and others) where traffic volumes already approach capacity.

Conversion of Street System - Conversion of Crystal City from a one-way street system to a two-way operation would require careful coordination with transit operations. With the elimination of Clark Street as a general-purpose street, southbound traffic would be confined to Crystal Drive. Crystal Drive is one-way between Four-Mile Run and 26th Street South. Southbound Crystal City traffic may become congested in the future and need additional outlets south. Similarly, placing transit on Crystal Drive would affect southbound traffic as it would need to share the road with general traffic while the street would become an increased focus for through traffic—Clark Street does not extend further south than 27th Street South.

6.2.c. Quality of Life

Concerns have been raised over the prospect of transit vehicles operating on streets in established residential neighborhoods. Noise, visual, and safety concerns are most frequently cited. In addition, should transit need to displace parking, residents would be inconvenienced. Many properties do not have off-street parking.

Public meetings, held over the course of this study, elicited many quality of life concerns from residents within the corridor. Numerous concerns were expressed about the Powhatan Street corridor, including the following: disruption of traffic; adverse impacts on the landscaping and parks in the corridor; and fear of displacement from the transitway or its appurtenances. Generally, residents of this neighborhood saw more harm from the introduction of additional transit than the compensating benefits.

Similarly, at the northern end of the study area, concerns were raised over the introduction of new transit on Crystal Drive north of approximately 18th Street South. Visual impacts and loss of maneuverability were of concern. Residents also expressed concern over noise and round-the-clock intrusion of large transit vehicles.

Future plans for the Arlington North Tract, while not fully developed, suggest that this land will be dedicated to active recreational space. Given the limited opportunities for such recreation in the County, the citizens' task force planning that development expressed a desire to retain the maximum amount of space for recreational uses. Any route that would split the tract or require appreciable land was considered undesirable by the task force.

6.2.d. Physical Obstacles

Several physical barriers could become a problem with respect to new transit alignments. As previously described, transit on the west side of the Metrorail line at the Braddock Road Metrorail Station would be physically separated from the Metrorail Station entrance. Either a tunnel or overpass would be costly to construct and still leave potential passengers with a lengthy walk to the Metrorail.

Further north, the alignment for the Monroe Avenue Bridge leaves uncertainties and potential problems for transit. Two plans are currently under consideration:

- Replacing the bridge in place along the current "dog leg" alignment.
- Replacing the bridge with a straightened alignment that would run north-south across the CSX tracks. The ultimate configuration of this bridge would favor some alternatives over others. Furthermore, if the bridge is straightened, transit alignment alternatives east of the Braddock Road Metrorail station would need to cross Route 1, potentially at an acute angle creating a need for unique traffic control.

Transit alignments running from the North Tract into the Pentagon Reservation would need to cross over or under I-395/Shirley Highway and again over Route 110. These structures would be lengthy, complex, and costly. Similarly, transit alignments traveling north along Eads, Fern, or Jefferson Davis Highway would need to cross under I-395, posing questions of vertical and horizontal clearance.

6.2.e. Department of Defense Security Concerns

From a transportation perspective, the Pentagon and surrounding military reservation have always been unique. The building contains more than 23,000 employees and sits adjacent to a major transit interchange. It is also the nation's defense headquarters. The recent attack on the Pentagon emphasizes the need for balancing the transportation demands of the location with very real security requirements.

Some of the unique aspects of the Pentagon and the security concerns it raises for transit include:

- Any routing of transit through the reservation needs to be planned in coordination with professionals responsible for security planning. This would include, at a minimum, using the future relocated Metrorail

Entrance Facility (MEF) and all standoff requirements associated with transit in proximity to the Pentagon Building.

- Security concerns need to be given weight as alternatives are developed.

- The study team needs to engage in ongoing consultations with the Pentagon staff to ensure that this project is cognizant of evolving thoughts on Pentagon security.

Generally, alternatives that rely on aerial structures within the Reservation area would be undesirable. Structures over I-395 or Route 110 at any point would offer a vantage point of the Pentagon that is of concern to security planners for the Department of Defense. Generally, any alternatives that carry BRT or LRT into the Reservation and make use of the existing and newly built Pentagon MEF would be considered preferable to others.

6.3 TIER 1—ALTERNATIVES SCREENING

The factors previously described were used to select those alternatives that best met the goals of the study. The full set of alternatives was shared with the public in a series of public meetings. Smaller, civic association meetings further examined some of the more promising alternatives to further reduce the list.

Table 6-1 summarizes the primary considerations. Each of the ten alignments was assessed for its potential to generate ridership, the extent to which the proposed alignment would travel through transit-supportive land uses, and the potential for noise impacts to residential areas. A more detailed summary of these measures is shown in Appendix C.

Table 6-1 highlights the strongest and poorest alternatives for the measures described. Those alternatives that have the strongest performance are shown in bold and are outlined. Those that have the poorest performance are shown in italics and are shaded. The middle tier of alternatives is shown without highlighting.

This table shows that no one alternative stands out as either the strongest or weakest of the ten. Each has strengths—for example, Alternative D is likely to generate the greatest ridership but would pass through less transit-oriented development than the other alternatives and potentially produce the greatest adverse noise impacts on residential areas. This table illustrates the importance of considering segments of each of the alternatives. The best

segments of each should be combined to form the strongest alternatives which would then be studied in greater detail.

Table 6-1
Tier 1 Alternatives Evaluation

Evaluation Criteria		Ridership potential (thousand of trip ends)		Potential Impacts	
Alternative	Description	Total Ridership Potential	Non-home based trip ends	Extent to which the alternative passes through transit-oriented development (existing and proposed)	Potential noise impact to residential areas
A	West	556	**197**	***low***	moderate
B	east-east	***463***	***171***	**high**	**none**
C	central	541	196	moderate	moderate
D	east-west	**595**	**216**	***low***	***high***
E	west-center	**564**	**203**	moderate	moderate
F	west-east	522	192	moderate	low
G	west	**558**	196	moderate	moderate
H	east-west	***458***	***171***	moderate	high
J	Central to Clark	***480***	***178***	**high**	moderate
K	Metrorail	***420***	***142***	moderate	**none**

Notes: Ridership potential is the number of trip origins or destinations within ½-mile of the alignment. Both total and non-home based trip ends were enumerated.
Compatibility with land use plans was subjectively determined by noting the proposed land uses surrounding the alternative. Transit-oriented development was defined as commercial, office, and high-density residential property.
Potential noise impact to residential areas represents the extent to which the alignment passes through residential areas.

Legend: Poorest performers are shown in italics and shaded ***xxx***

Strongest performers are shown in bold and outlined **xxx**

6.3.a. BRT/LRT Alternatives

In the Tier 1 phase of alternatives development, it was determined that all of the linear alignments being studied could be used for either Bus Rapid Transit or Light Rail Transit. Thus, the recommended linear alignment is the same for both modes.

Within the Braddock Road Metrorail Station area, the alternatives using Madison and Fayette Streets were considered preferable over the others.

These alignments maximize ridership while balancing the other concerns expressed in the previous sections of this chapter.

For purposes of this study, it was agreed that the alignment should follow the preferred Monroe Avenue Bridge configuration (the straightened bridge) and therefore the alignment would travel north on Route 1. The proposed alignment would continue north on, or adjacent to, U.S. Route 1 to a point near East Glebe Road. Here the alignment would turn eastward along the future proposed Town Center. The alignment would turn northward again along the future Potomac Avenue, passing behind the current Potomac Yard Retail Center.

The alignment would then continue north across the easternmost of the old Four-Mile Run railroad bridges and along the proposed transitway through the South Tract. The alignment would pass under the National Airport Viaduct at 26th Street South and then northward along Clark Street.

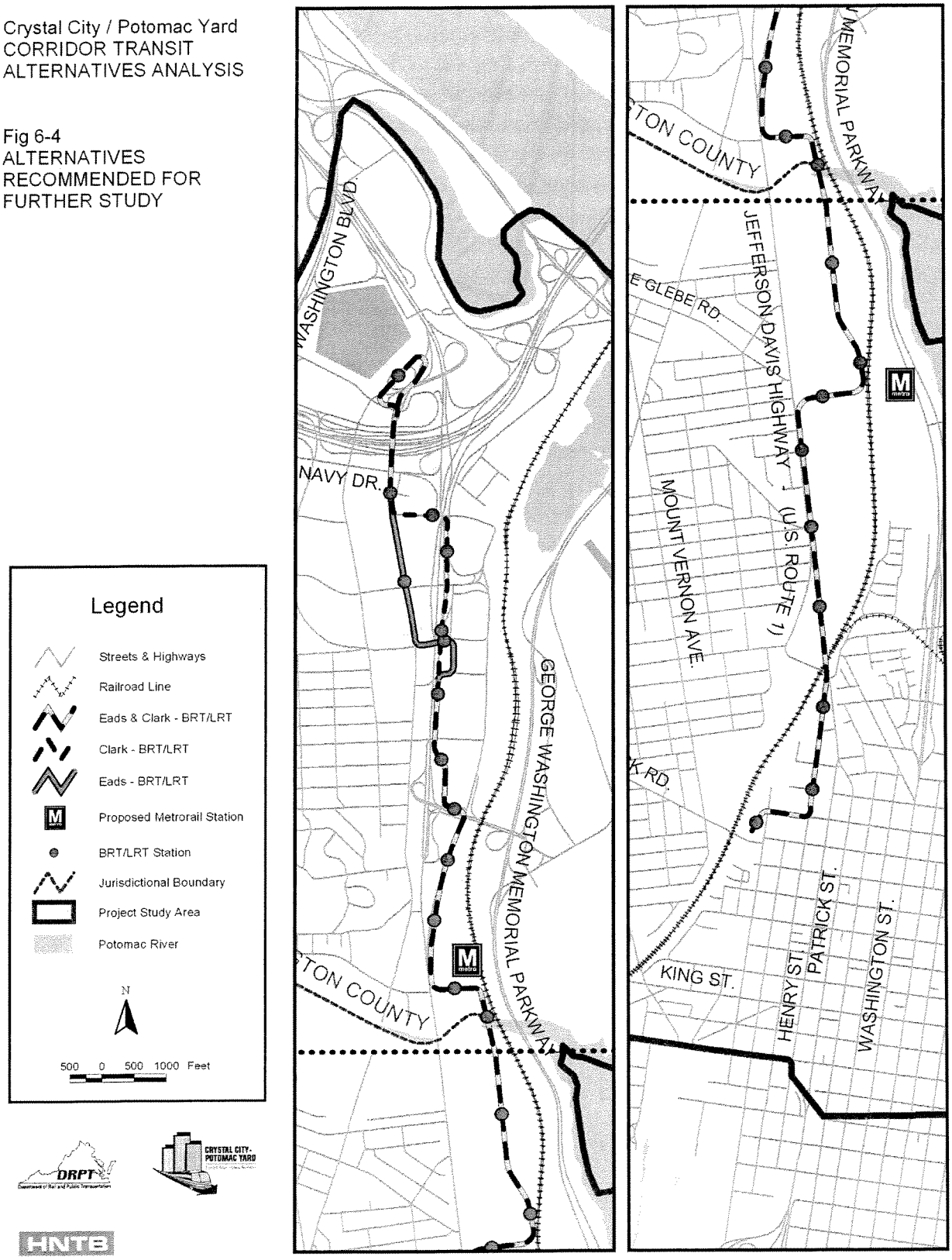
The proposed alignment would continue north on Clark Street to 20th Street South. From here, two possibilities remain available. The first would be to continue north on Clark Street to 12th Street South before heading westward to Eads Street. The other would be to turn east on 20th Street South to Clark Place, then north on Clark Place and then west on 18th Street South. From 18th Street South the alignment would cross Clark Street and U.S. Route 1 before turning north on Eads Street. These two alternatives would come together at 12th Street South and Eads Street where the alignment would continue northward on Eads Street and into the Metro Entrance Facility on the south side of the Pentagon Building. Both of these routes could be used for either BRT or LRT and are shown in Figure 6-4.

6.3.b. Metrorail Alternative

A Metrorail alternative would follow the existing Metrorail tracks running through the study area. Additional stations would be considered near East Glebe Road on the east-side of Potomac Yard and just north of Four-Mile Run. The Potomac Yard station would be near the proposed town center and directly serve the future development in the Yard. The Four-Mile Run station would offer direct service to the South Tract area. Both stations were recommended for further study. Figure 6-5 shows the location of these stations.

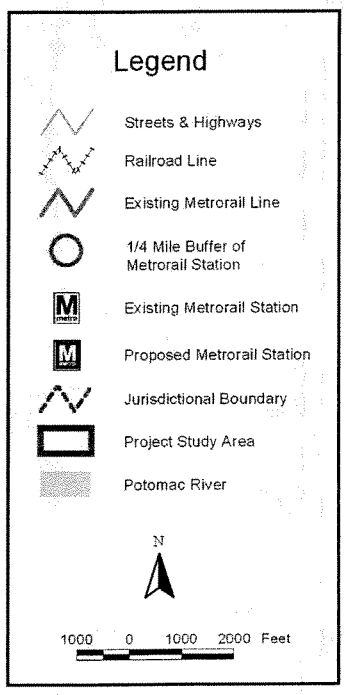
Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

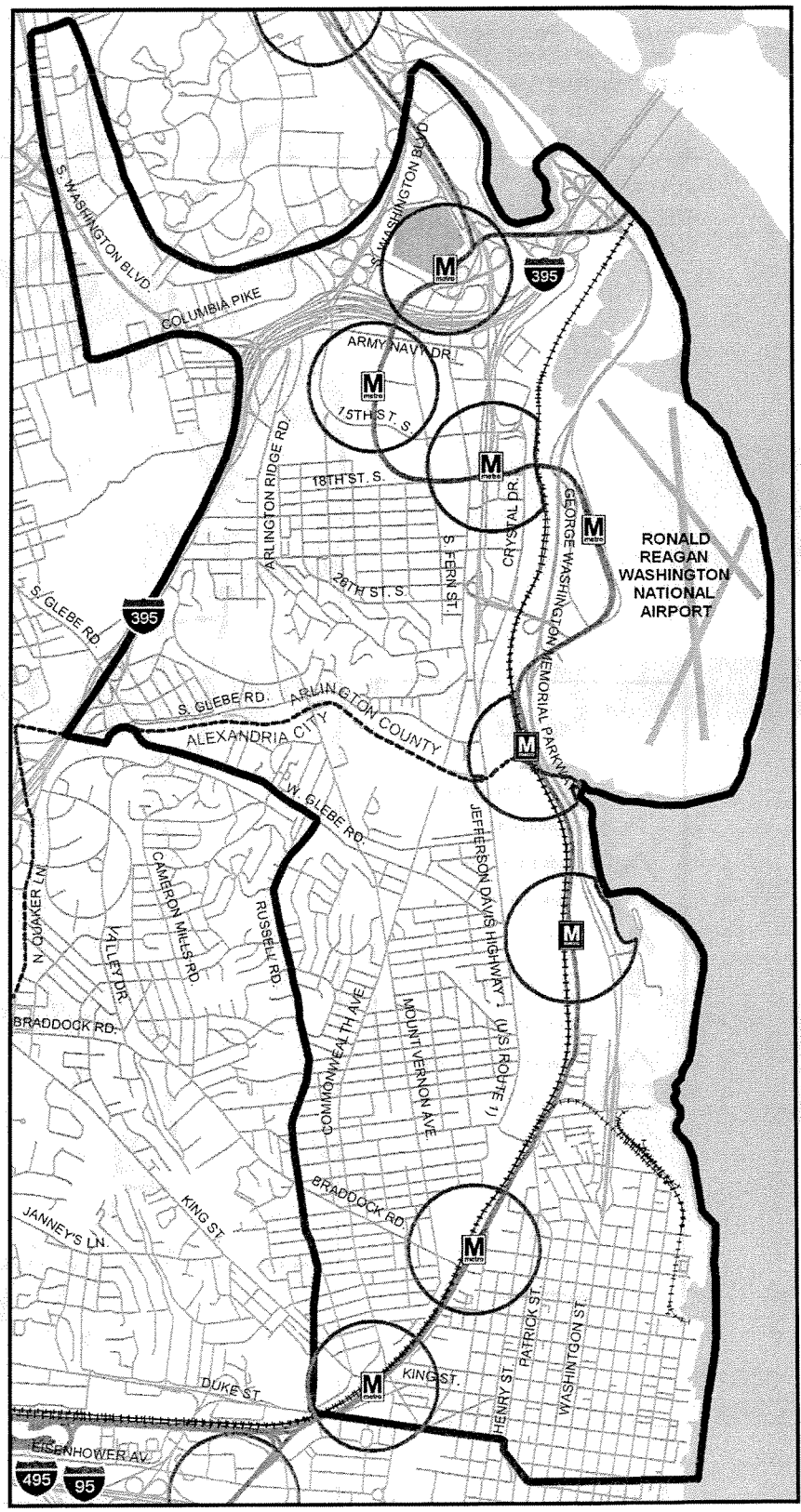
Fig 6-4
ALTERNATIVES
RECOMMENDED FOR
FURTHER STUDY



Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig 6-5
METRORAIL ALTERNATIVES
RECOMMENDED FOR
FURTHER STUDY





7. TIER 2—ALTERNATIVES DEVELOPMENT

The Study Team, with the aid of various committees and community input, took the recommended Tier 1 alternatives and developed additional detail for each. Refinements were made in the alignments to address concerns identified in the previous analysis. Station locations were refined and relocated to better serve the study area and match locally developed plans. Sites for a maintenance facility and a means of bringing proposed transit vehicles to that facility were also considered. This chapter describes the refinements and elaborations to reach the final Tier 2 alternatives for this study.

7.1 STATIONS

An important element of the refinements between the Tier 1 and Tier 2 alternatives was to the stations. At the more detailed Tier 2 level, careful consideration was given to the placement of stations and integration of the stations with the surrounding area. This section describes the location of stations of the Tier 2 Alternatives.

The stations, regardless of mode, will need to be high quality, attractive, and functional. The general style and configuration of a Metrorail station will need to be consistent with the existing 84 stations within the current Metrorail system. Local variations that complement the Crystal City/Potomac Yard Corridor would be encouraged.

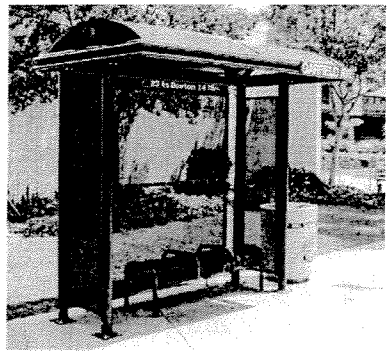
For both light rail transit or bus rapid transit, the stations would match the caliber of those of heavy rail stations. This is important, especially for BRT as its main selling point is it rail-like characteristics.

7.1.a. BRT/LRT Station Types

As mentioned above, the configuration of the Metrorail stations would need to be consistent with the existing system. As there are no existing BRT or LRT systems in the Metropolitan Washington DC area, the study team developed station configuration parameters for these two modes.

BRT or LRT stations would be configured to meet the setting in which they are placed and level of passenger demand. Four station types are described below. Each station serves a different level of anticipated usage. Lower-usage stations are smaller and have minimal features, while heavy-use stations are larger with the most features. Every station would be expected to have high-quality state-of-the-art features consistent with a sophisticated modern transit system.

Light Use Station - This station would be used for light traffic. The station would be covered to protect from rain and have at least one bench. This station would be primarily for residential and lower-use areas. Automatic Vehicle Location would be used on all buses; fare machines and a passenger information display (a display indicating from where and/or when the next bus is coming) is recommended, but not required. For some stations, due to the light use (and increased risk of vandalism) a fare machine might be best located inside a nearby local establishment such as a convenience store.



This light use station has a passenger information display.

Moderate Use Station - For use on Route 1, at a minimum, and in retail areas. Shelters would be larger (if not completely enclosed) to accommodate several benches. Fare machines, passenger information displays, and enhanced design features are required.

Heavy Use Station - For commercial areas and high traffic residential areas. These stations would have all the benefits of the moderate use stations, but with platforms to facilitate at-grade boarding.

An example of a heavy use station. (Photo courtesy David Pirmann)

Multimodal Station - These stations would be additions built onto existing Metrorail facilities. Transit stations would be covered, if not completely enclosed, and offer direct connection to Metrorail. If an addition is not allowed, a multimodal station at close proximity could be used with a walkway connecting the two facilities.

7.1.b. BRT/LRT Station Guidelines

This section of the report looks at stations by zones, similar to those in the previous chapters. The exception is the Potomac Yard area, which is divided into neighborhoods to illustrate how transit and the transit stations can be made compatible with the new development. Note that stations are tentatively named and used only for purposes of this study. Final decisions on station names will be made subsequent to this study.

Braddock Road Metrorail Station Area - Three stations would serve this area: Braddock Road, Montgomery Street, and Bashford Lane. Since it would offer

a connection to Metrorail, the proposed Braddock Road Station would be expected to be a high-use station. The Braddock Road Station would also be close to the proposed office development on the other side of the CSX/Metrorail line. As the area is mostly residential, the remaining two stations would be light use stations with minimal requirements. Seating and a shelter may be all that would be required for those stations.

Potomac Yard Area - North of the Braddock Road area is Potomac Yard. According to the revised *Potomac Yard Urban Design Guidelines, 13 September 2001*, the Yard is divided into six "neighborhoods." This section describes how transit can be integrated into the Potomac Yard neighborhoods. Of course, new development is also taking place in the South Tract and will also be addressed. For each neighborhood, there is a unique center and character.

- Swann Neighborhood: The Swann station is located at the intersection of U.S. Route 1 and Swann Avenue. Swann is the main thoroughfare for this primarily residential neighborhood. Mixed-use development would surround the future station in the area between U.S. Route 1 and Main Street. Therefore traffic would not be as heavy as in the town center, but enough to warrant a moderate use station. Custis and Simpson Fields Stations would serve the neighborhoods in this area, respectively. Like Swann station, these potential stations are in primarily residential neighborhoods with mixed-use development west of Main Street. Thus, all three stations will be similar in station type.

  Swann, Custis, and Simpson Fields stations are located along Route 1. These stations are located along finger parks, thus the stations are along major cross streets and can add to the landscaping of the area. This Tier 2 alignment would be on the eastern side of the highway, in proximity to the new development. Stations along Route 1 will be identical in basic station components but could be decorated to show the individual characteristics of the different neighborhoods.

- The Potomac Yard Town Center Neighborhood: This area will include the hotel and several retail and mixed-use developments. The parcel also has a large town green. The transit alignment would follow Hume, which passes south of the park. The width of Hume is only thirty-three feet, meaning that transit would be in-street and occupy most of the width. There would be enough room for one lane of vehicular traffic. The proposed station would be directly south of the town green. This would be the flagship station for Potomac Yard in Alexandria. The station would be heavy-use and its design should borrow from the surrounding buildings in the town center.

Another proposed station, aptly named Retail Center, would be located behind the present Potomac Yard Shopping Center and in front of the cinema. Although located in the rear of most of the facility, the proposed station still provides access to the existing development. Furthermore, the development at the shopping center has a life of about twenty years; thus, if this transitway is approved, by the time it is in operation, the stores that are currently there may be replaced with other stores or the current buildings could be modified to have back entrances.

Finally, the South Glebe Road station is located between Potomac Avenue and U.S. Route 1. This station would serve some low-density residences, and therefore should be a low-use station. This station could also serve as a possible transfer station to a future Metrorail station. This station should be built at a minimal level, with enough land to expand and upgrade as necessary.

Arlington Potomac Yard South Tract Area - The two potential stations in the Arlington County South Tract are part of the *Potomac Yard Staff Report* and were not modified in terms of location. The station proposed at 26th between Crystal Drive and Clark Street is required to blend in with the surroundings. The design guidelines state that "the design vocabulary should reflect the character developed within the buildings and open spaces in which they sit." The study team would consider this a moderate use station, but the *Staff Report* describes interim stations fitting somewhere in between light and moderate use.

> The transit service shall feature attractive and high quality shelters to protect patrons at stop. Shelter locations mush be lit, and provide wind and rain protection. They shall be of a consistent design through the project, and should be designed to be moveable to allow flexibility in transit routing as the project and its bus system matures.[1]

As the interim service is upgraded to BRT or LRT, a moderate use station would be in place if one is not there already.

Crystal City - In this area, the alignment splits into two options. Despite the split, the number of stations is the same for each option. Stations here were first located according to land use, and then to preserve the desired station spacing. The result of that process resulted in stations located at Clark Street south of 23rd Street, and Clark and 18th Street South.

[1] City of Alexandria City Council (1999). *City Council Special Meeting Wednesday, September 8, 1999—6:00 P.M. on Potomac Yard/Potomac Greens* (---). Alexandria, VA: City of Alexandria, Attachment E, 4.17

The priority in Crystal City was to create a connection to the existing Metrorail station. Both Tier 2 options have an 18th Street South station for this purpose. Because of its location, the 18th Street South station would be a transfer station. However, due to the lack of available land within Crystal City, building a larger station may be problematic. Thus, a covered level platform station would be the ideal. In addition, the Clark Street alignment allows a station at 12th Street/Route 1 to accommodate the need for access to the North Tract and the other surrounding areas. As the area is mostly residential, a light-use station is recommended.

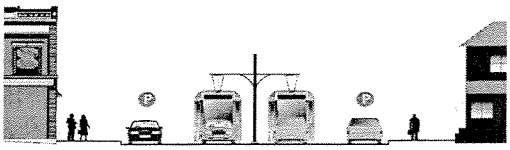
Crystal City has high-density development throughout the area, so placing a station near a high-density land use was not an issue. Therefore, the study team placed potential stations to preserve ¼ mile minimum spacing. This led to the creation of the 26th, 23rd, and 15th Street Stations (Eads alignment).

Pentagon - The last two stations serve northern Crystal City and the Pentagon, respectively. The 11th Street station serves the mixed-uses, mostly residential, that exist between Army-Navy and 12th Street. The anticipated light use would warrant a smaller station. However, the Pentagon station is a regional transfer station and would require an extensive transfer facility.

7.2 BRT/LRT TYPICAL SECTIONS

The proposed alignments would travel through a diverse array of street sections between Braddock Road and the Pentagon. The routes through Crystal City and near to the Braddock Road Metrorail Station run on streets that are predominantly two-lane, necessitating that transit operate on the same lanes as general automobile traffic. Where the proposed alignments use wider streets, the preference would be to reserve lanes solely for transit. For most of the proposed alignments, transit would have its own right of way.

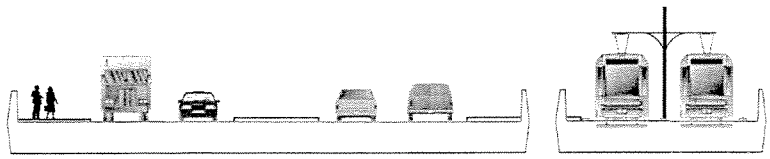
Typical Section – Madison & Fayette Streets
(Braddock Road Metrorail Station to Monroe Avenue Bridge)
Northbound view



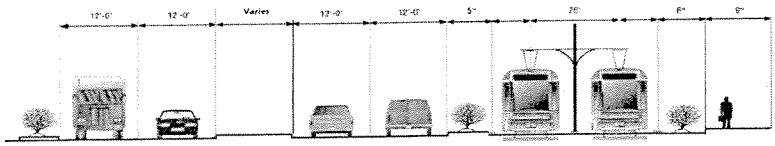
The first section starts at the Braddock Road Metrorail station and moves north along the alignment to the Monroe Avenue Bridge. The streets are narrow and the turns are tight. The streets of Madison and Fayette allow parking on one, if not both, sides of the street. Therefore, the right of way must be shared between the transit vehicle and general traffic.

Typical Section – Monroe Avenue Bridge (relocated)
(Fayette Street to North of Monroe Avenue Bridge)
Northbound view

Transit vehicles would have their own bridge across the CSX train line. Assuming the current Monroe Avenue bridge is extended, there would be a separate transit bridge adjacent to it. Northbound and southbound traffic would each have two lanes dedicated to them.



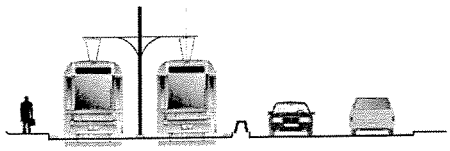
Typical Section – Route 1 / Jefferson Davis Highway (North of Monroe Avenue Bridge to East Glebe Road) Northbound view



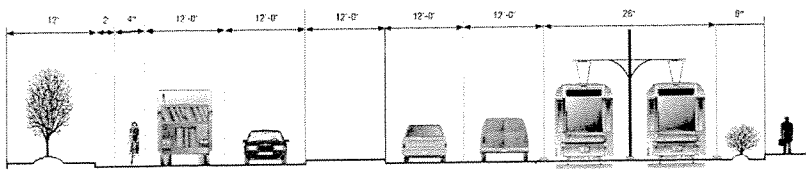
From the Monroe Avenue Bridge to East Glebe Road, Route 1 would carry the alignment on a separate guideway. The two-way transitway would be east of Route 1, providing access to both northbound and southbound trains on one side. The width of the right-of-way is large enough to carry the transitway, four lanes of general traffic, a median, and buffers around the transitway and sidewalks.

Typical Section – East Glebe Road (U.S. Route 1 to Potomac Avenue) Westbound view

As the alignment turns on to Hume Avenue, the road would become narrow due to the proposed Potomac Yard grid system. There is enough room to dedicate exclusive lanes to transit on the south side and have two-way general traffic on the north side. No parking would be allowed on Hume.

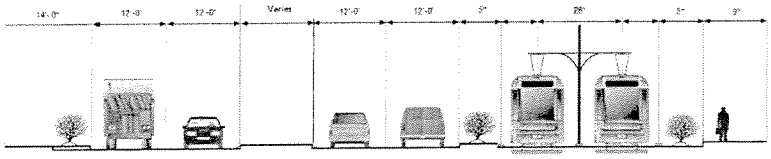


Typical Section – Potomac Avenue (East Glebe Road to South Glebe Road) Northbound view



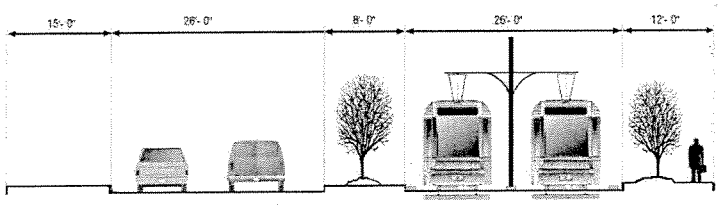
The section of Potomac Avenue from Hume Avenue to East Glebe Road has two lanes of traffic each for northbound and southbound traffic. A dedicated transitway would be located on the east side of the road. Unlike Route 1, there is no median between the northbound general traffic lane and the transitway.

Typical Section – South Glebe Road (Potomac Avenue to Crystal Drive) Westbound view



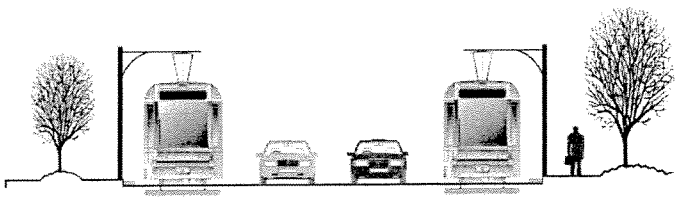
The alignment crosses into Arlington County, where right-of-way for a transitway has been secured within Potomac Yard. As the alignment makes a turn to the west on South Glebe Road, the section would be similar to that of the previous Potomac Avenue section except that there is a median between the westbound automobile lane and the transitway.

Typical Section – Crystal Drive (South Glebe Road to 26th Street South) Northbound view



The proposed alignment would turn north onto Crystal Drive where the transitway would remain on an exclusive right-of-way on the east side. Two lanes of northbound traffic would be located to the west with a sizeable median between them and the transitway.

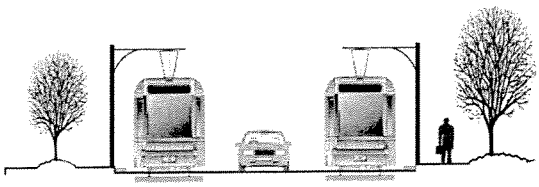
Typical Section – Clark Street (S. 26th Street to S. 20th Street) Northbound view



There are two typical sections of alignment on Clark Street. Along the southern portion of Clark Street (from 26th Street to 20th Street South), there are four lanes. The outer two lanes would be exclusively for transit, while the inner two lanes would be used by general traffic (southbound only). This section would not have medians.

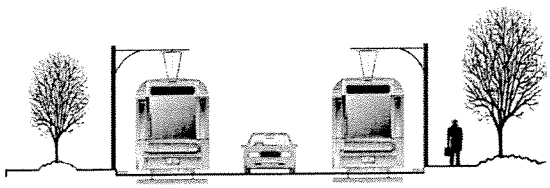
Typical Section – Clark Street
(S. 20th Street to S. 15th Street)
Northbound view

Closer to 20th Street, the right-of-way on Clark Street is similar to the Clark Place section (3 lanes, outer lanes for transit, inner lane for southbound general traffic). This section of Clark Street is elevated and therefore narrow.



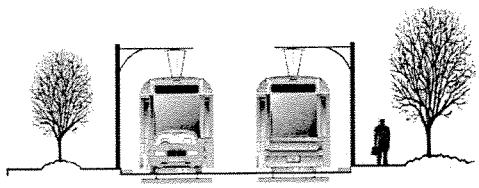
Typical Section – Clark Place
(S. 20th Street to S. 15th Street)
Northbound view

On Clark Place, the right-of-way is at its narrowest. There would be three lanes on this street, with exclusive northbound transit on the lane on the east side and exclusive southbound transit on the west side. The center lane would be for southbound automobile traffic.

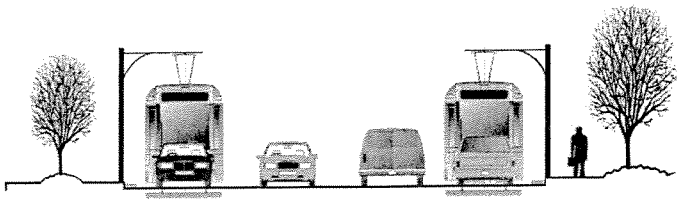


Typical Section – Clark Street
(S. 15th Street to S. 12th Street)
Northbound view

The northern portion of Clark Street (20th Street to 12th Street) narrows to two lanes, requiring mixed traffic operation in the southbound lane (west side). The northbound lane would be used exclusively for transit. Since Clark Street would be a one-way street for southbound vehicles, it would not be possible to have the northbound lane open to mixed traffic.

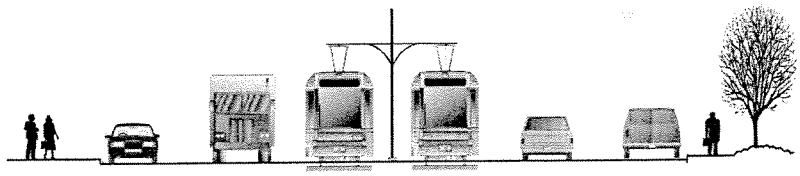


Typical Section- S. 12th Street
(Clark Street to Eads Street)
Westbound view



As the proposed alignment turns west onto 12th Street, the right-of-way becomes wider. There is also two-way traffic. This section is four lanes wide with one lane on each outer side for transit. General traffic would use all four lanes making the outer lanes mixed traffic.

Typical Section – Eads Street
(S. 18th Street to I-395)
Northbound view



The Eads Street section would run from 18th Street to the Pentagon on the Eads Street alignment and from 12th Street to the Pentagon on the Clark Street alignment. Eads, being a wide street, can accommodate six lanes in the right-of-way. The outer two lanes would be for curbside parking, the lanes adjacent to the parking lanes would be for automobile use, and the two inner lanes would function as the exclusive transitway. From east to west, there would be a parking lane, a northbound general traffic lane, a northbound transit lane, a southbound transit lane, a southbound general traffic lane, and a parking lane.

7.3 POTENTIAL MAINTENANCE FACILITIES

A new storage and maintenance facility would be required for BRT or LRT to operate in this corridor, but not for Metrorail. Generally, the storage and maintenance facility would include adequate room to store the entire fleet of vehicles assigned to the corridor. The facility should also have the space and equipment to perform the full range of maintenance and repairs that typically occur in operations including mechanical and body work. The feasibility of sending vehicles to another location, beyond the project limit should be considered and will vary in feasibility depending upon the particular mode deployed in the corridor.

7.3.a. BRT Maintenance Facility

Buses could be maintained elsewhere in the region either at WMATA, DASH, or a private contractor's facilities. The additional cost of transporting buses to and from the corridor should be weighed against the cost of operating a facility for the exclusive use of Crystal City/Potomac Yard operations.

While Metrobus operates a maintenance facility on South Glebe Road at U.S. Route 1, that facility does not have adequate capacity to serve the Crystal City/Potomac Yard corridor's service. For the purposes of this Alternatives Analysis, the study team will assume that Metrobuses would be reassigned to other locations that have capacity, making available space in the Four Mile Run garage. This would likely necessitate the expansion of other garages to accommodate those reassigned from Four Mile Run. This might also necessitate the installation of specialized equipment for the Crystal City/Potomac Yard service. A low-floor, articulated bus, for example, might not fit on the current lifts at Four Mile Run garage.

An alternative to utilizing the Four Mile Run garage would be use a site considered for an LRT maintenance facility. These locations will be described in detail in the following sections.

7.3.b. LRT Maintenance Facility

Light rail vehicles could not readily be maintained at another location and so consideration would need to be given to the construction of a facility for service in this corridor. Given the planning for light rail in many other corridors in the Metropolitan Washington area, the facility need not be situated within the project study area and could serve multiple transit lines. Again, the benefits of an offsite location need to be weighed against the cost of transporting LRT vehicles to and from that location. For the purposes of

this Alternatives Analysis, the study team assumed that the LRT facility would be located within the study area.

7.3.c. Metrorail Maintenance Facility

Should heavy rail be selected for this corridor, no additional maintenance facilities would be required. Metrorail vehicles would continue to operate in the corridor, stopping at any new stations in Potomac Yard and Crystal City. No increase in the transit vehicle fleet is anticipated and therefore no new maintenance facilities would be required. Existing facilities would suffice.

7.4. LRT MAINTENANCE YARD EVALUATION

The corridor presents several opportunities for maintenance facilities in close proximity to the proposed LRT transit routes. Generally, any location within the corridor should meet the following criteria:

- Approximately 6 acres of land
- Vacant site or currently used for industrial use
- Close proximity to the mainline of LRT
- Absent major environmental impacts
- Removed from residential neighborhoods
- Good road access with effective traffic flow controls and capable of handling freight deliveries
- Available water, sewer, poser, and gas utilities
- Good topography, soil, and drainage conditions.

Several options are available for locating the facility with respect to the proposed LRT route. Generally, it would be best to locate the maintenance and storage facility close to the midpoint of the alignment so as to minimize the deadhead mileage between the facility and the main trunk line. A central location would also be beneficial for failure management situations.

An alternative with the Crystal City/Potomac Yard corridor would be to locate the facility at the end of the run. In this case, the North Tract is removed from any existing neighborhoods and consequently would have less impact on the community than sites further south.

Yet another approach would be to locate the maintenance facility near a station. This would allow for removing a vehicle from the mainline in the event of a failure.

Figure 7-1 illustrates the eight sites identified in the corridor. Each site meets the above-mentioned criteria to varying degrees. A description of each of the eight sites follows.

The Twin Bridges site - This site, the former location of a Marriott hotel, lies vacant east of the I-395/Boundary Channel Drive interchange in Arlington County. With 6.2 acres, it is a sizeable lot with good road access. Utility access and soil conditions are good as well. However, with its close proximity to residential areas and its lack of proximity to the transitway, it may not be the most feasible.

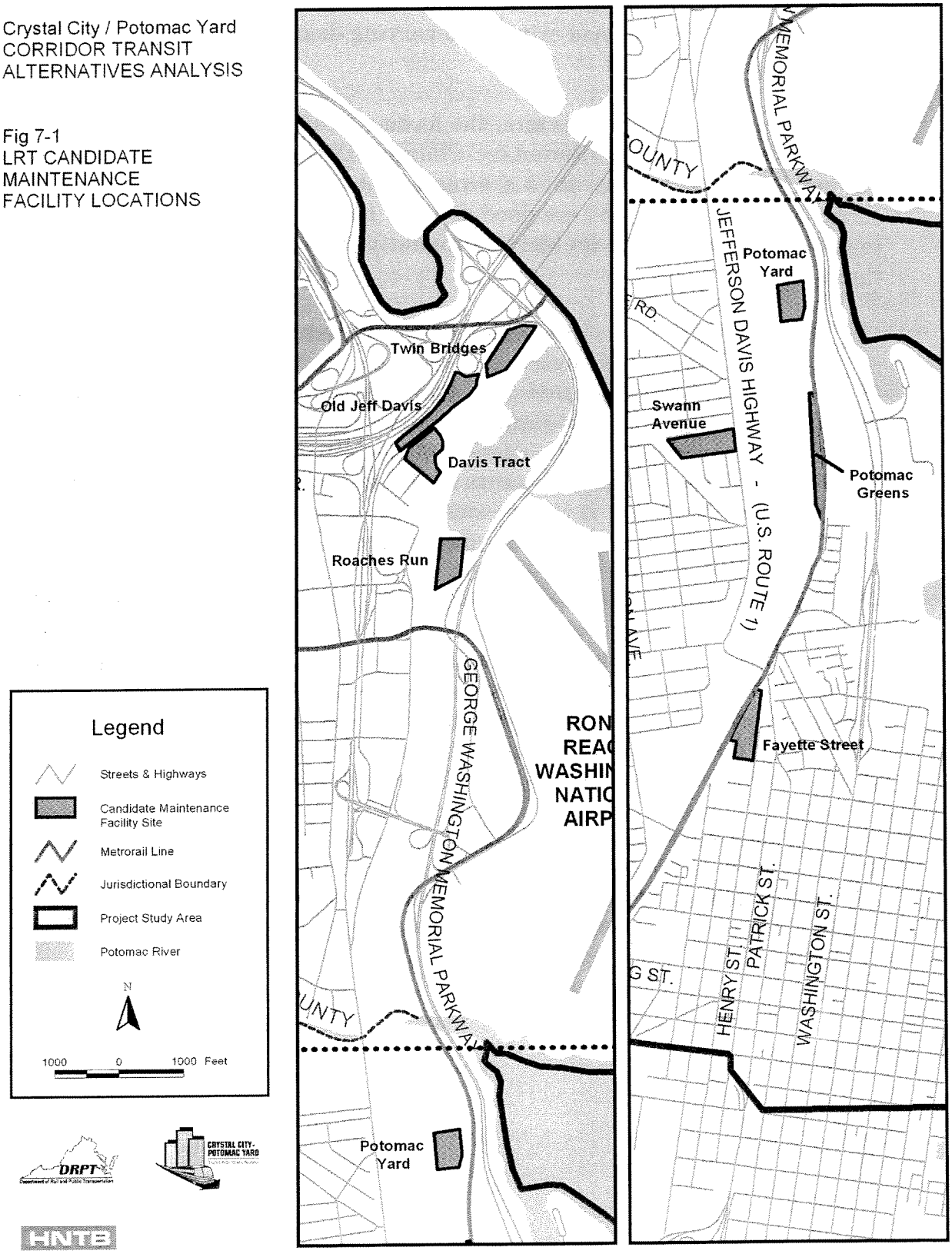
Old Jeff Davis site - This area follows the corridor of Old Jeff Davis Highway, the Jefferson Davis Highway before newer limited-access highway was constructed. This long, narrow corridor along the southeast corner of the I-395/Boudnary Channel Drive interchange is the largest of the eight potential lots. There are no potential major environmental impacts due to its location. The road access is good, with access to utilities and good soil conditions. Like the Twin Bridges site, it is not close to the transitway and it is close to residential areas. In addition, the site is occupied.

Davis Tract - On the other side of Old Jeff Davis Highway and the Old Jeff Davis site is the Davis Tract. This 6.3 acre site lies under the flight path of Ronald Reagan Washington National Airport, restricting the use of the land. Adding to the list of cons, it is not located near the transitway, it lies in close proximity to residential areas, and the land has an environmental issue with hazardous materials. Among the pros, it has fair access to roads and available utilities, and it has good soil and drainage conditions.

Roaches Run site - The 5.7 acre site is one of the smaller options on hand. The site is currently vacant/industrial, has fair road access, utilities, and soil conditions. However, the land is currently occupied, close to residential areas, and has some forest, wetland, and park impacts.

Crystal City / Potomac Yard
CORRIDOR TRANSIT
ALTERNATIVES ANALYSIS

Fig 7-1
LRT CANDIDATE
MAINTENANCE
FACILITY LOCATIONS



Potomac Yard site - This area is currently a parking lot for the movie theater at the Potomac Yard Shopping Center. Even though it is the smallest tract of the eight tracts under consideration (5.2 acres), it is one of two sites located closest to the Amtrak and Metrorail corridor. It also has no potential major environmental impacts, fair road access, good access to utilities, and good soil conditions. The only disadvantage, in addition to size, is its proximity to residential areas. The Potomac Greens neighborhood is nearby, and at build-out, the residential areas will not be far away from the site.

Swann Avenue site - Located across Jefferson Davis Highway from the proposed Potomac Yard site lies the Swann Avenue tract. The vacant/industrial land contains 7.1 acres with good utility access and soil conditions. This tract is the only one of the eight that has good road access as opposed to fair access. The land is not close to residential areas, but it may present some environmental impacts because of it proximity to green space. Its location along Jefferson Davis Highway allows excellent access to the transitway.

Potomac Greens site - This area is also along the Metrorail and Amtrak corridor, resulting in good access to the transitway. The 5.8 acre parcel has no potential environmental impacts with good access to utilities and good soil conditions. Because the parcel is within Potomac Yard, the area would be near residential areas across the proposed Potomac Avenue. In turn, road access would be poor. The area is under consideration by the City of Alexandria for a dog park.

Fayette Street site - The Fayette Street site is located just south of the Monroe Avenue bridge and east of the Amtrak and Metrorail corridor. It is currently used for industrial purposes and lies near the proposed transitway. Although the site is near U.S. Route 1, the grid system and traffic control could become problematic, giving the area fair but not good road access. The 6.5 acre site in itself is in good condition. There are no potential environmental impacts, it has access to utilities and has good soil conditions.

Table 7-1 indicates the compliance with the determined LRT maintenance yard criteria for each site. Based upon this analysis, a storage and maintenance facility within the study area is feasible and should be investigated further in subsequent studies.

Table 7-1
Potential LRT Maintenance Facility Sites

Criteria / Site	Approximate land area	Vacant or currently used for industrial use.	Close proximity to the mainline of the LRT.	Potential major environmental impacts.	Proximity to residential neighborhoods	Good road access with effective traffic flow controls and capable of handling freight deliveries.	Available water, sewer, poser, and gas utilities.	Good topography, soil, and drainage conditions.
Twin Bridges	6.2	Yes	No	forest, wetlands, and park impacts	Yes	Fair	Yes	Yes
Roaches Run	5.7	Yes	No	forest, wetland, and park impacts	Yes	Fair	Yes	Yes
Swann Avenue	7.1	No	Yes	Impacts to greenway space	No	Yes	Yes	Yes
Davis Tract	6.3	Yes-use restricted by National Airport flight runways	No	Hazardous materials	Yes	Fair	Yes	Yes
Potomac Yard	5.2	No (parking lot)	Yes	no impacts	Yes	Fair	Yes	Yes
Potomac Greens	5.8	Yes-under consideration for city dog park	Yes	no impacts	Yes	No	Yes	Yes
Fayette Street	6.5	Yes-industrial	Yes	no impacts	No	Fair	Yes	Yes
Old Jeff Davis	7.6	No	Yes	no impacts	Yes	Fair	Yes	Yes

8. TIER 2—EVALUATION

The Tier 2 transit alternatives were evaluated on the basis of the goals described in the project Purpose and Need Statement.

8.1 TIER 2—MEASURES OF EFFECTIVENESS

One or more evaluation criteria were established for each of the six goals to evaluate the alternative in light of the project's goals. The eight evaluation criteria and the corresponding goals established for this project are shown in Table 8-1.

Table 8-1
Measures of Effectiveness

Measures of Effectiveness by Goal	
Goal 1: Increase non-highway modes of travel	• Ridership per average weekday • Number of new transit passengers
Goal 2: Minimize adverse impacts on commuter routes	• Change in travel time by auto • Change in travel time by transit
Goal 3: Increase the utility of transit	• Non-work trip ridership per average weekday • Peak hour trips • Work trips
Goal 4: Provide increased circulation and mode choice	• Transit mode share to the Study Area and selected sub-areas
Goal 5: Optimize use of financial resources	• Construction cost • Operating & maintenance costs
Goal 6: Increase use of the region's existing rail transit system	• Change in Metrorail ridership

8.1.a. Ridership per Average Weekday

Ridership on the proposed system for the year 2025 was forecast using the MWCOG Version 2 travel demand forecast model. This TP Plus forecasting tool incorporates the transportation system and demographics for the region to predict travel behavior in the planning horizon year. Daily ridership for each of the alternatives was forecast using this tool. The ridership of the BRT and LRT alternative is based only upon station boardings. Since all trips on the BRT and LRT system would originate in the study area,

ridership would be double counted if alightings were also used. The Metrorail alternative, however, is in reality a station alternative, with trips either beginning or ending outside of the study area. Recognizing that a boarding outside the study area is an alighting inside the study area (and vice-versa), the study team felt it was appropriate to count both the boardings and alightings. By using this approach, the alternatives are placed on an equal footing.

8.1.b. Number of New Transit Passengers

New transit in the corridor would result in ridership on the proposed service. Not all of that ridership, however, would be former automobile drivers or passengers. Some ridership could shift from existing transit modes such as bus or Metrorail, to the proposed service. This measure identifies the ridership that would be new to transit and consequently would result in reductions in automobile traffic within the corridor.

8.1.c. Change in Travel Time by Auto

The introduction of additional transit could result in a decrease in travel times through the corridor for general traffic. The corridor was modeled using VISSIM, a micro-simulation model that simulates traffic behavior on the streets of the study area. Year 2025 traffic volumes, street configuration, and signal timing/phasing were entered into the model. The model was then run both with and without BRT or LRT on the streets. A comparison of the travel times through the corridor was then made.

8.1.d. Change in Travel Time by Transit

The introduction of higher speed transit is expected to result in faster travel by transit through the corridor. Travel times for buses currently operating along Route 1 were noted. These operations were then incorporated into the VISSIM model for the study area and compared to the proposed transit alternatives.

8.1.e. Non-work Trip Ridership per Average Weekday

An objective of both the City and County is for the Potomac Yard development to be transit-oriented and for it to promote a "transit-oriented lifestyle." The local jurisdictions envision an environment in which people will shop, dine, and travel to midday business appointments using transit. One measure of this phenomenon is the extent to which midday non-commuter travel occurs. The non-work trip ridership is a measure of how well the transit alternatives accommodate that type of activity. As with the

daily ridership measure, both boardings and alightings were counted for the Metrorail alternative.

8.1.f. Peak Hour Trips

Another important measure of the utility of transit is the extent to which it attracts peak hour trips and thereby helps take commuters off the road at the most congested times. While transit would not be expected to eliminate congestion in the Crystal City/Potomac Yard Corridor, it could help to reduce highway congestion in the critical peak period.

8.1.g. Work Trips

A companion to the peak hour travel measure is work trips. About one-third of transit travel in the Metropolitan Washington area is for work trips, and this therefore represents an important measure of the utility of transit in this corridor.

8.1.h. Transit Mode Share

This measure can be applied to the study area as a whole, with very diverse demographics and housing stock, and to individual geographical areas. Of greatest interest are:

- The Crystal City area
- The section of Potomac Yard in Alexandria
- The Potomac Yard South Tract

The mode share is intended to demonstrate whether transit is a viable alternative throughout the study area.

8.1.i. Capital Cost

Transit projects typically require substantial expenditures of funds. The capital cost include the one-time cost to construct the system, procure the land, purchase the rolling stock and other equipment, and implement any environmental mitigation measures. Even the best project cannot be implemented if funds are not available to construct it. Both the absolute and the relative capital cost are important and can be used, in conjunction with ridership measures, to assess the effectiveness of each transit solution. For example, a lower cost solution may not move as many people or achieve some of the other goals of the project as well as a higher cost option, and therefore, it may be less effective. This measure permits that comparison.

8.1.j. Operating and Maintenance Cost

Operating and maintenance costs can be particularly significant in evaluating alternatives because they occur annually for the life of the project and because they are usually borne by the local jurisdiction without support from the Federal Government.

8.1.k. Increase Use Of Metrorail

The Metropolitan Washington region has made a substantial investment in a 103-mile heavy rail system. Generally, any transit alternative that increases Metrorail ridership would represent a positive factor in the consideration of that alternative.

8.2 TIER 2—EVALUATION OF ALTERNATIVES

The BRT, LRT, and Metrorail alternatives were evaluated using the criteria described in the previous section. Table 8-2 shows the results of that evaluation. This section is an interpretation of those results.

8.2.a. Increase Non-highway Modes of Travel

The range in ridership between the five alternatives is not wide. Nonetheless, one alternative outperforms the others: the BRT-Eads Street alternative. This alignment produces around 36,500 riders per day; the BRT-Clark Street alternative has similar results. The differences in the forecast ridership between BRT and LRT are largely attributable to the fact that BRT was modeled with 6 minutes headways (due to capacity issues), while LRT was modeled with 10 minutes headways. Of the alternatives, Metrorail produces the lowest ridership with 31,000 trips per average weekday. Note that the difference between the highest and lowest ridership is a relatively insignificant 5,500 riders per day.

The ridership generated by any of these alternatives would appear sufficient to warrant the proposed service. Transit vehicles operating in the corridor would carry a significant number of passengers. During portions of the peak periods, at the maximum load points, vehicles could be operating at capacity. This indicates that a genuine travel demand would be met by any of the alternatives.

As indicated by the second measure for this goal, "Number of New Transit Passengers," approximately one-third of the ridership would be new to transit. This indicates that the proposed alternatives offer a transit service

that would better meet the needs of travelers within the corridor than the existing bus and Metrorail operations.

8.2.b. Minimize Adverse Impacts on Commuter Routes

The Study Team compared the travel times in the enhanced baseline condition with the alternatives (for automobile and transit). Negative numbers indicate reductions in travel time. Although the alternative with the largest negative number would be the leader in this criterion, travel time should also be considered in light of the overall travel time through the corridor. For instance, the BRT-Clark alternative leads in this criterion with travel times ranging from 16 to 18 minutes. The Metrorail alternative is at the bottom of the category with *increased* travel time, but its overall travel time through the corridor is only 13 minutes. Metrorail would result in increased travel time through the corridor because of the increased dwell time, stopping, and starting at the two new stations.

Generally, these alternatives would reduce travel time through the corridor regardless of mode. The proposed signal priority that would be given to BRT or LRT operations would also reduce travel times for traffic operating on U.S. Route 1. Travelers using transit would have a quicker way to traverse the corridor than would result from current bus service operating in the year 2025.

One consequence of the improved travel speeds on U.S. Route 1 would be increased delay to traffic on the intersecting streets. Traffic on the local streets in Crystal City, in particular, would find increased delay resulting from priority being given to traffic on U.S. Route 1. Adjustments to the signal priority plan, such as reducing or eliminating the priority in certain segments of the corridor, might be necessary to prevent long queues on the cross streets.

Table 8-2
Tier 2 - Evaluation of Alternatives

Alternative / Measure of Effectiveness	BRT - Alternative 1 (Eads Street) (6 min. headway)	BRT - Alternative 2 (Clark Street) (6 min. headway)	LRT - Alternative 1 (Eads Street) (10 min. headway)	LRT - Alternative 2 (Clark Street) (10 min. headway)	Metrorail Alternative (2 stations) (3 min. headway)
Goal 1: Increase non-highway modes of travel					
Ridership per average weekday	36,500	36,100	33,700	33,600	31,000
New Trips	11,100	7,300	5,800	5,300	11,700
Goal 2: Minimize adverse impacts on commuter routes					
Change in travel time by auto (minutes/trip, Braddock-Pentagon) NB (22 min.)	-3.7 (18 min)	-3.7 (18 min)	-1.6 (20 min)	-1.5 (21 min)	N/A
Change in travel time by transit (min./trip, Braddock-Pentagon) NB (31 min.)	-12.6 (18 min)	-13.6 (17 min)	-10.3 (21 min)	-11.6 (20 min)	+3.0 (13 min.)**
Change in travel time by auto (minutes/trip, Braddock-Pentagon) SB (18 min.)	+0.8 (19 min)	-1.7 (16 min)	-1.6 (17 min)	-1.7 (17 min)	N/A
Change in travel time by transit (min./trip, Braddock-Pentagon) SB (26 min.)	-6.4 (20 min)	-8.8 (18 min)	-2.3 (24 min)	-6.0 (20 min)	+3.0 (13 min.)**
Goal 3: Increase the utility of transit					
Non-work trip ridership per average weekday	12,200	12,000	11,200	11,200	10,300
Peak hour trips	5,100	5,100	4,700	4,700	4,300
Work trips	24,100	23,800	22,200	22,200	20,500
Goal 4: Provide increased circulation and mode choice					
% transit to/from Crystal City and South Tract of Potomac Yard	20.6	20.6	20.3	20.5	20.9
% transit to/from South Tract of Potomac Yard	15.4	15.3	14.9	15.2	16.2
% transit trips to/from Potomac Yard in Alexandria of Potomac Yard	12.0	12.0	12.0	12.0	13.9
% transit trips to/from Study Area	15.2	15.1	15.1	15.0	15.7
Goal 5: Optimize use of financial resources					
Construction cost (millions of $)	50.3	56.2	206.9	208.5	138.9
Operating & maintenance costs (millions of $/year)*	9.3	9.4	11.4	11.5	4.2
Goal 6: Increase use of the region's existing rail transit system					
Change in Metrorail ridership (riders)	(8,103)	(11,096)	(9,066)	(11,584)	6,837

* includes feeder bus service costs

** additional Metrorail stations result in 3 minute increase in Metrorail travel time through corridor

NB = northbound SB = southbound

8.2.c. Increase The Utility of Transit

Generally, the predominant use of transit is for commuting (trips to work and back), and this is accounted for by calculating work trips and peak-hour trips. The BRT-Clark Street alternative has the best results for this criterion, as it generates the highest work trips and ties for the highest peak hour trips. Once again, the gap between the highest and lowest performer is minimal. The BRT-Clark alternative generated 24,100 work trips per day while the last-place Metrorail alternative generated 20,500. For peak hour trips, the alternatives generated 5,100 to 4,300, respectively.

An issue that the study team also addressed was the ability to increase non-work trips (i.e. shopping and tourist trips). With its 20,600 trip ridership, the Metrorail alternative is 8,400 trips higher than the next alternative (BRT-Eads).

The introduction of BRT or LRT into the Crystal City/Potomac Yard Corridor would offer a superior level of local service to that offered today. The proposed service would be enhanced over today's service. Frequent stops and headways combined with priority service both for the traffic signals and right-of-way would allow persons within the corridor to make use of transit for not only commuting to and from work but also midday and after-hours activities.

The Metrorail alternative also offers increased utility for transit. Additional stations, closer to the proposed development in Potomac Yard, would give high quality transit access to areas currently lacking. In addition, the feeder bus network, proposed to complement the Metrorail alternative, could serve as a local circulator. This would also make midday and after-hours travels easier.

8.2.d. Provide Increased Circulation and Mode Choice

For these measures, the study team was looking for an alternative that would increase the transit mode share and/or decrease the automobile mode share. Once again, the gap between highest and lowest is so narrow (2%) that there is virtually no difference. Compared to each other, no one alternative outperforms any other by a significant factor. The Metrorail alternative however has the best numbers. This measure is not effective in discriminating between alternatives.

The more significant impact indicated by this measure is that much of the modal shift would occur in the peak periods of the day. At times when

highway congestion is at a peak, transit mode share would increase the most. Consequently, the relatively modest daily shifts to transit would be even more significant during the peak periods of the day.

8.2.e. Optimize Use of Financial Resources

Construction of light rail transit in this corridor would cost approximately $200 million, including guideway, stations, station facilities, rolling stock, maintenance and storage facilities, right-of-way, and a transit-only bridge. Bus rapid transit in the corridor would cost approximately a quarter of that price ($50 to 60 million), and would operate with basically the same attributes as the LRT alternative. The cost of constructing the two Metrorail Stations falls between the cost of constructing BRT and LRT and costs about $140 million.

For operations and maintenance, the costs of the three alternatives range from $4.2 to $11.5 million. The least costly alternative would be Metrorail, which only requires staffing and maintenance for the two stations. The other alternatives include maintenance of the entire system, including track and rolling stock.

Present value costs over 20 years show that the maintenance and operating costs for the light rail alternatives are more than twice the amount of the BRT. Using present value, the Metrorail alternative cost over 20 years becomes more expensive than the BRT. Thus, the cost for the BRT construction and long-term operation and maintenance are more affordable than the other alternatives.

Appendix I summarizes the capital and operation and maintenance cost calculations for each alternative.

8.2.f. Increase Use of Region's Existing Rail Transit System

This measure compares Metrorail ridership under each Tier 2 alternative with the Metrorail ridership in the baseline condition. The baseline condition recommended for comparison includes:

- Metropolitan Washington's Constrained Long Range Plan projects
- Increased local bus service consistent with the WMATA Regional Bus Study
- Transit signal priority along Route 1 for existing and expanded bus service
- Minor street and intersection improvements.

The increase in local bus service in the baseline would have a tendency to attract some ridership away from the Metrorail system.

In addition, each of the alternatives includes a robust feeder bus service. Consequently, the Metrorail ridership for the linear alternatives is reduced by ridership that shifts to the parallel service, including the feeder network. Metrorail ridership declines under both the BRT and LRT alternatives, by as much as 11,000 riders in the LRT-Clark alternative. Under the Metrorail alternative, Metrorail ridership would increase by nearly 7,000 riders per day.

Overall, the reduction in Metrorail ridership for the BRT and LRT alternatives is no more than a loss of 11,000 riders in a system that is forecast to have a daily ridership in excess of 1.2 million (Noteably, this loss in ridership is to the predicted increases in ridership in 2025, not to current ridership numbers.) This change of approximately one percent is not statistically significant for the system. In summary, none of these alternatives significantly affects Metrorail ridership. Furthermore, this measure addresses changes in Metrorail ridership, and not Metro system ridership, which include both buses and trains. Overall transit ridership increases under all alternatives when compared with the Baseline condition.

8.2.g. Environmental Considerations

None of the transit alternatives is likely to significantly affect the natural environment. Most of the alternatives are located in public right-of-way, with the exception being Potomac Yard, where the identified right-of-way falls within the proposed limits of the future Potomac Yard roadway network. Additional land taking would also be required to widen U.S. Route 1 to

accommodate the transitway and to build a transit bridge parallel to the future straightened Monroe Avenue Bridge.

Not many natural areas will be affected. The largest, most significant area in terms of environmental concerns would be Four Mile Run. However, there are no plans to build future bridges across Four Mile Run. Potomac Avenue and the transitway will be built without new bridge construction.

Noise pollution is also minimal for residential communities. All of the alignments are in mostly commercial or retail areas except in the Braddock Road area, which is mostly two and three story townhouses.

8.3 TIER 2—ASSESSMENT OF FEASIBILITY

All of the Tier 2 alternatives improve non-highway modes of travel. Each alternative increases new ridership and overall transit ridership in the corridor.

All the transit alternatives reduce overall travel time for of all modes. The new transit options operate faster than transit operates in the baseline condition (regular buses with signal priority). Automobiles are able to travel faster because of transit signal priority. All traffic on U.S. Route 1 would benefit from changes to the traffic signal systems. Since almost all of these alternatives have similar results, there is no reason why any of the options would not be feasible. Only one alternative increases travel time for the automobile and, in that case, by less than a minute.

All of the alternatives contribute to increased circulation and mode choice. In some areas, the increase in transit mode share is as high as 5 percent. For the study area, transit share rises from 10 percent to 15 percent. In Potomac Yard (Alexandria), transit share rises from 7 percent to 15 percent.

The Tier 2 analysis shows that Metrorail ridership would decrease with all the alternatives except the Metrorail alternative. The decrease is directly attributed to the robust feeder bus network, serving as an attractive parallel and alternative system. However, the reductions are insignificant compared to the increase in Metrorail ridership forecast from present-day to 2025.

The five alternatives represent dramatically different levels of financial investment. BRT has the lowest capital cost with ranges from $50 to 60 million, followed by the Metrorail stations with a cost of about $140 million, and the LRT with a cost just under $210 million. The present value of the operating and maintenance costs can be combined with the capital costs to

compare the overall costs of each of the alternatives. Table 8-3 shows the 20-year present values of each alternative.

Table 8-3
Crystal City/Potomac Yard Corridor Transit Alternatives Analysis
20-Year Present Value

Alternative	Capital Costs (in millions of $s)	Annual Operating & Maintenance Costs (in millions of $s)	Present Value of O&M Costs (in millions of $s)	20-year Present Value (in millions of $s)
BRT-Eads	50.3	9.3	106.7	157.0
BRT-Clark	56.2	9.4	107.8	164.0
LRT-Eads	206.9	11.4	130.8	337.7
LRT-Clark	208.5	11.5	131.9	340.4
Metrorail	138.9	4.2	48.2	187.1

The cost of the 20-year present values for the BRT is slightly lower than the Metrorail options, while the LRT remains significantly more costly. The capital cost of LRT is four times that of BRT, while over twenty years the LRT cost is approximately double the cost of BRT. Life cycle resting factors may further diminish the differences between alternatives.

9. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the conclusions and recommendations for the Crystal City/Potomac Yard Corridor Transit Alternatives Analysis. The recommendations coming from this study include a recommendation for the locally preferred alternative.

At the most general level, the study concluded that all of the alternatives studied (Metrorail, LRT, or BRT) would be effective in meeting the project goals. Using the objective measures noted in Chapter 8 of this report, it can be noted that the alternatives produce similarly beneficial results for many of the measures of effectiveness. However, the study recognizes that there were some significant differences in the performance of the alternatives that led to the selection of the locally preferred alternative (LPA).

9.1. POTENTIAL TRANSIT SOLUTIONS

This section is a narrative that discusses the differences between the modal and alignment alternatives and provides the basis for the conclusions and recommendations in the subsequent sections.

9.1.a. LRT versus BRT

There are differences between the ability of BRT and LRT to meet the project's goals. The following issues tend to distinguish the two alternatives.

Cost – The BRT alternatives are appreciably less costly to construct than the LRT alternatives. Operating and maintenance costs differ by about 20 percent. When examined on a long-term basis, it was found that the twenty-year present value of LRT, that is, the current funds needed to build and operate the system over the next twenty years, is about twice that of the BRT alternative.

Life cycle cost analysis of each alternative was not performed as part of this study. Experience has shown that the life cycle costs for certain elements of the alternatives, primarily vehicle costs, may be lower for LRT than BRT. While LRT vehicles are generally more costly than BRT vehicles, their longer life span permits each vehicle to operate for more years without replacement. Other elements of the two systems, guideway, stations, traction power system, communications systems, etc., do not offer a similar advantage.

Capacity - The vehicles and headways used in this study were determined by the ability of each alternative to carry the anticipated passenger load. The LRT alternative assumes a two-car, articulated vehicle operating on ten-minute headways. At the peak load point, these vehicles would be operating at capacity. The BRT alternative assumes an articulated bus operating on six-minute headways and it too would be filled to capacity at the peak load point.

The potential for expansion of the BRT system is limited, should the ridership exceed the projections of this study. Reduction in the headways, without elaborate operational control and complete control of the entire route, free from interference from other vehicles, could negatively affect BRT operations causing vehicles bunching and travel delay. In addition, the increased frequency of the BRT service might push the limits of the signal priority system and either produce excessive delay on the cross streets or add delay to the travel times of the BRT vehicles.

The LRT alternative, on the other hand, should operate comfortably on ten-minute headways. Marginal reduction in headways and increase in vehicle sizes or length could meet future demand beyond that forecast in this study.

Demand – BRT generates greater ridership operating at six-minute headways than the LRT alternatives generates at ten-minute headways. However, it is likely that the ridership for LRT would be similar to the BRT forecasts if headways were similarly reduced. (Notably, this would increase the cost of LRT and capacity issues do not warrant the reduction in headways.) BRT service would also be more flexible and have the ability to extend its service area into the surrounding communities and therefore has the potential to increase ridership in this manner.

Other Considerations – It is likely that BRT could be implemented in a much shorter timeframe than LRT since modified service could start prior to the construction of a full-scale transitway, and thus some service could be implemented to coincide with the construction of new development.

The conclusion in comparing these two modes is that BRT currently represents the better transit solution for the corridor. Overall, bus rapid transit appears to be better suited to the study area. It offers more flexible service at a lower cost. In addition, a modified BRT could potentially be implemented in the corridor as development is constructed. Long-term capacity considerations would not appear to sufficiently outweigh other advantages to BRT service.

9.1.b. Metrorail Versus BRT/LRT

Metrorail and the linear alignments also differ significantly in their ability to meet the goals established for the project. The major differences are discussed below.

Cost - The cost of constructing the Metrorail alternative is significantly higher than the cost of constructing the BRT alternatives, but significantly lower than the cost of constructing the LRT alternatives. The BRT capital cost range from $50 to $60 million; the Metrorail stations capital cost are in the range of $140 million; and the LRT capital costs are in the range of $210 million. Operating and maintenance costs are lower for Metrorail than either BRT or LRT. However when the twenty-year cost of operation and maintenance are combined with the capital cost, the cost of BRT is slightly lower than the Metrorail alternative. The twenty-year present value cost of BRT is in the range of $160 million, while the twenty-year present value cost of Metrorail is in the range of $190 million. The twenty-year present value cost of LRT is significantly higher that either BRT or Metrorail at approximately $340 million.

Connectivity - The Metrorail alternative offers easier connectivity to the rest of the Washington region. Travelers could potentially reach the Crystal City/Potomac Yard area with a one-seat ride under a Metrorail alternative. However, a BRT/LRT alternative offers greater connectivity within the study area.

Notably, the ridership forecasts indicate that none of the alternatives, regardless of mode, generate significant ridership internal to the Crystal City/Potomac Yard area. Each alternative produces no more than 3,000 daily trips internal to this core area. Conversely, all of the alternatives generate most of their ridership from beyond the immediate study area.

One factor that may contribute to the lower internal ridership may the nature of the travel demand forecast model. The Version 2 model covers the Metropolitan Washington region, and was developed to determine travel throughout the region. Trips within the study area (internal-to-internal trips) are much more sensitive to local factors too subtle for the model to acknowledge. At least three factors would contribute to internal trip-making not fully integrated into the regional model.

- Location – The precise origins and destinations of trips become significant at the local level. If the walk to the station becomes longer than the walk to the final destination then transit fails to serve the

trip. If the walk access, wait time, and travel time exceeds the time of a trip made solely by walking, the trip will not be made by transit.

- Service quality - the general appeal of the transit. An attractive, modern, comfortable bus will draw more riders than a standard transit bus. A bus that looks like a modern light rail vehicle may attract more riders
- Reliability - the ability to maintain schedule and a frequency that is accommodating to patrons. A patron who is sure that the BRT will arrive at the time on the schedule will be more likely to use the BRT. Similarly, a BRT line with headways so short that a patron would not need to consult a schedule would also result in high patronage.

Notice all these factors are qualitative. Such measures are beyond the scope of the regional model. However, the sensitive nature of transit rider behavior may produce internal-internal trips that are overlooked by the model. Thus could result in ridership figures much greater than generated in this analysis.

The BRT and LRT alternatives would generate nearly half of their ridership from transfers with the Metrorail system. Riders will transfer from the Pentagon, Crystal City, and Braddock Road Metrorail stations to travel to points within the corridor. Table 9-1 shows the ridership by mode of access for each alternative. Note that the Metrorail ridership includes both boarding at the proposed Metrorail stations and alightings.

Demand - Generally, all of the alternatives generate similar daily boardings. The difference between the high of 36,500 for the BRT alternative on Eads Street and the 31,000 for the Metrorail alternative is not terribly significant. Given the nature of the analysis, the level of detail in the regional model, and refinements made to reflect the local study area, it is fair to assume that Metrorail would generate fewer boardings than the other alternatives but the precise difference cannot accurately be determined.

However, the differences in the way that passengers access these modes are more significant. Generally, Metrorail passengers would rely less heavily on auto and bus service to access the system than would passengers using BRT or LRT in this corridor. The Metrorail alternative could therefore reduce the need for feeder bus service and park-and-ride facilities.

Table 9-1
Ridership by Mode of Access

Alternative	Daily Boardings	Walk Access Passengers	Bus Access Passengers	Auto Access Passengers	Metrorail Transfer Passengers
BRT Eads	36,500	9,600	8,100	2,700	16,100
BRT Clark	36,100	9,200	8,500	2,600	15,800
LRT Eads	33,700	8,500	7,100	2,300	15,800
LRT Clark	33,600	8,100	7,400	2,300	15,800
Metrorail	31,000	10,200	4,300	900	15,500

Other Considerations – As discussed in the previous section of this chapter, it is likely that a modified BRT system could be implemented in a shorter timeframe than either LRT or Metrorail; this would allow service to begin operation as Potomac Yard is developed.

In summary, the Metrorail alternative could offer better regional connection and could minimize the demand for feeder bus service and park and ride facilities. BRT and LRT, on the other hand, would offer a locally oriented focus, better suited for carrying people around the Crystal City/Potomac Yard area. The capital cost of the BRT alternative is significantly lower than the capital cost for the Metrorail alternative. This is significant as acquiring the funding for the capital cost can significantly slow down a project's construction and implementation. In addition, the twenty-year present value cost of the BRT is lower than the cost of the Metrorail alternative.

After comparing these three modes, the conclusion of the study team and Policy Advisory Committee is that the benefits of constructing the BRT alternative outweigh the benefits of constructing the Metrorail alternative as BRT offers greater flexibility, slightly higher ridership, lower construction costs, lower twenty-year present value cost, and the potential for faster construction and implementation.

9.1.c. Clark Street Verses Eads Street Alternatives

Alternatives for both BRT and LRT were developed to travel down Clark Street and Eads Street. The Tier 2 evaluation criteria indicate only a slight and likely insignificant difference between the two in terms of their ability to meet the project's goals.

Each of the alternatives has the potential to more effectively serve certain segments of the transit market as described below. Additional considerations therefore, would best aid in selecting a preferred route.

Commuters - The Clark Street alignment most directly serves the office buildings within Crystal City and therefore offers better service for work trips.

Residents - The Eads Street alignment passes directly in front of several large residential properties. The Clark Street alignment less directly serves residents living along Crystal Drive. Much of Crystal City, however, is able to make use of the existing Crystal City Metrorail Station. The Eads Street alignment, therefore, may better offer service to a new residential market.

Off-peak riders – The Clark Street alignment runs closer to the mixed uses of Crystal City (specifically the part of Clark Street east of Route 1 and north of Virginia Route 233) and would serve the proposed recreational uses of the Arlington County North Tract. Consequently, shoppers, sporting event patrons, and performance patrons may be better served by a Clark Street alignment. The Eads Street alignment runs closer to Pentagon City and would offer indirect service to this area, which includes shops, restaurants and other services.

Generally, there does not seem to be significant difference in operating on either Clark or Eads Street.

9.2 STUDY CONCLUSIONS

This section summarizes the major conclusion reached in the discussion of transit solutions from the previous section (Section 9.1).

1) Bus Rapid Transit, Light Rail Transit, and Metrorail are all viable alternatives that effectively and positively respond to the goals established for this project.

   - All alternatives improve non-highway modes of travel.
   - All alternatives result in significant transit ridership.
   - All alternatives result in reduced travel times for all modes in the corridor (except Metrorail which results in slightly increased travel times due to the addition of new stations stops on an existing line).
   - All alternatives contribute to increased circulation and mode choice.

2) Projected transit ridership for the corridor provides ample justification to advance the project into the Federal Transit Administration project development process and New Starts Program.

3) The Bus Rapid Transit Alternative (Eads Street) produces the greatest transit ridership. Much of the difference between the projected BRT and LRT ridership is based on the differing headways used for the analysis. (The headways for BRT were reduced to six minutes when the model predicted ridership that meant that the capacity needs could not be met by the original ten-minute headways.)

4) The BRT and LRT alternatives provide better access to areas within the corridor; while, the Metrorail alternative provides better connectivity to the rest of the Metropolitan Washington DC area.

5) The capital costs of the BRT alternatives are significantly cheaper than the capital cost of either Metrorail or LRT. The BRT capital cost range from $50 to $60 million; the Metrorail stations capital cost are in the range of $140 million; and the LRT capital costs are in the range of $210 million. The lower cost of the capital outlay needed for BRT could speed up project construction and operation as compared to the LRT or Metrorail alternatives.

6) Although the difference between the overall cost of BRT and Metrorail diminish when the twenty-year present value cost is calculated, the cost of construction and operation of BRT is slightly less expensive

than Metrorail. The twenty-year present value costs are as follows: $160 million for BRT; $190 million for Metrorail; and $340 million for LRT.

7) All modes can currently handle the ridership forecasted for their vehicles, however, if ridership exceeds the projected 2025 levels, BRT may have difficulty meeting the additional demand since further reduction of headways could negatively affect both the BRT service and local traffic.

8) BRT appears to offer the most cost-effective means of serving the traveling public and creating the transit oriented development envisioned by Arlington County and the City of Alexandria. Operating on either Clark or Eads Street appears to achieve similar results, although the analysis indicates that the Eads Street alternative is slightly stronger. Both should be further examined in the environmental document.

9.3 STUDY RECOMMENDATIONS

The project purpose and need statement defined the objectives for a future transit system in the Crystal City/Potomac Yard Corridor. Based upon that statement and the results of the evaluation criteria that articulate the specific project objectives, the study makes the following recommendations:

1) Bus rapid transit should be advanced as the locally preferred alternative (LPA) for transit in the Crystal City/Potomac Yard Corridor for purposes of the Federal Transit Administration's New Start Evaluation.

2) Bus Rapid Transit, Light Rail Transit, and Metrorail are all viable options in regard to transit ridership for the Crystal City/Potomac Yard Corridor and therefore all three options should be carried forward into the environmental impact study.

3) The selection of the BRT alternative should not preclude future construction of one or more future Metrorail stations in the corridor. Future changes in the corridor beyond those currently envisioned for the year 2025, including changes in the Potomac Yard Retail Center, development of the North Tract, and proposed residential development in Crystal City may render transit capacity, beyond a BRT/LRT operation, necessary.

4) A number of issues that warrant further review have been documented in the next chapter (Chapter 10). These challenges should be addressed in the future environmental analysis.

9.4. POLICY ADVISORY COMMITTEE RESOLUTION

The project's Policy Advisory Committee, following a review of the evaluation criteria and based upon the recommendation of the Technical Advisory Committee, passed a resolution endorsing BRT as the locally preferred alternative for purposes of the FTA New Starts Evaluation while also recommending that the other alternatives be further studied in subsequent phases of project development. A copy of the Policy Advisory resolution is shown in Appendix L.