Study of Transit Alternatives in the Dulles Airport Access Road Corridor

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The median of the Dulles Airport Access Road has long been considered a potential transit corridor to connect Dulles Airport with the rest of the Washington metropolitan area. KPMG Peat Marwick was engaged by Fairfax County, Va., to examine the feasibility of transit development in the corridor. The study examined a variety of transit options including express bus, high occupancy vehicle facilities, and various rail technologies. Station locations, ridership estimates, operating costs, and capital costs were prepared for each alternative. Based on the results of the analysis, it was recommended that the county implement an enhanced express bus system utilizing the high level of service provided by the Dulles Access Road, with station sites identified for interim use for express bus operation and potential ultimate conversion to a rail or other higher technology when operational and financial conditions warrant such action.

The Dulles Airport Access Road corridor runs between Washington Dulles International Airport and the West Falls Church Metrorail station. The corridor serves the northern portions of Fairfax County, Va., including the "new town" of Reston, as well as a large area north and west of the airport in Loudoun County. The corridor also skirts the northern edge of the Tyson's Corner area, a major mixed-use suburban activity center and the largest "downtown" in Virginia.

The corridor was identified as a major transportation link in the early 1960s, when Dulles Airport was built in what was then an undeveloped part of the western suburbs of Washington, D.C. Development in the corridor occurred rather slowly until two rather recent events coincided in the late 1970s and early 1980s, namely, the deregulation of the airline industry and the explosive growth in suburban office development. Since then, the corridor has grown rapidly, and this growth is projected to continue into the next century (Figures 1, 2, and 3).

In addition to the rapid increase in population, employment, and airport-related travel, the corridor is projected to continue to be influenced by increases in car ownership and dispersal of commuting patterns, leading to even more rapid increases in work person-trips that must be accommodated on the transportation network (Figure 4). One of the major changes that profoundly influences travel and the transit opportunities is the shifting of travel emphasis away from a radial orientation (to downtown Washington and the inner suburbs of Arlington) and toward a much more diffused pattern. By far the largest increases in travel will occur in the intra-corridor market and in cross-county travel.

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TRANSPORTATION SERVICES

The primary transportation feature of the corridor is the Dulles Airport Access Road and Dulles Toll Road, a unique "nested" pair of freeway facilities sharing a common right-of-way. The Access Road was built in the mid 1960s to serve Dulles Airport and consists of a four-lane freeway with access only to and from the Airport. This facility was built to accommodate an outer roadway system for local travel at a later date which was, indeed, constructed as the Dulles Toll Road in the mid-1980s. This latter facility has proved to be extremely popular, is running well ahead of traffic and revenue projections, and is currently under design for expansion from four to six lanes.

Traffic patterns in the corridor are also influenced by the connection between the corridor facilities and the rest of the region. The eastern end of the corridor connects directly with I-66, which is itself unique, being a four-lane freeway reserved for high occupancy vehicles (HOVs) and airport users in the peak direction during morning and evening rush hours. Other users of the corridor must exit at the Capital Beltway (I-495) or onto local streets serving the Tyson's Corner area.

Public transportation in the western part of the corridor features a system of buses that circulate in the Reston and Herndon areas and run express to the West Falls Church Metrorail system. Limited park-and-ride service is available from a small lot near the Access Road. Most of these express buses enter the Toll Road from general traffic ramps and then pass through a bus-only slip ramp to the largely uncongested Access Road for the express portion of the trip.

Service in Tyson's Corner area and the rest of the "inner" corridor consists of conventional local bus transit, with a major "hub" at a regional shopping center. Several routes connect from the Tyson's Corner area to the West Falls Church Metrorail station, although a well-developed shuttle system has yet to evolve. Some limited cross-county service is provided as well. Transit service to Dulles Airport is limited to express bus service from downtown Washington and van service from West Falls Church and various suburban activity centers in Northern Virginia and Maryland. There is almost no public transit service from Loudoun County.

The future of public transportation in the corridor is tied closely to the available right-of-way and planned highway improvements. As noted above, widening of the Toll Road is currently in the final planning stages, with a major local debate as to whether the additional capacity will be for general purpose traffic or restricted to HOVs. In addition, the Metropolitan Washington Airports Authority wishes to preserve enough right-of-way to add two additional lanes on the Access Road as air travel demands dictate. Thus, although the current

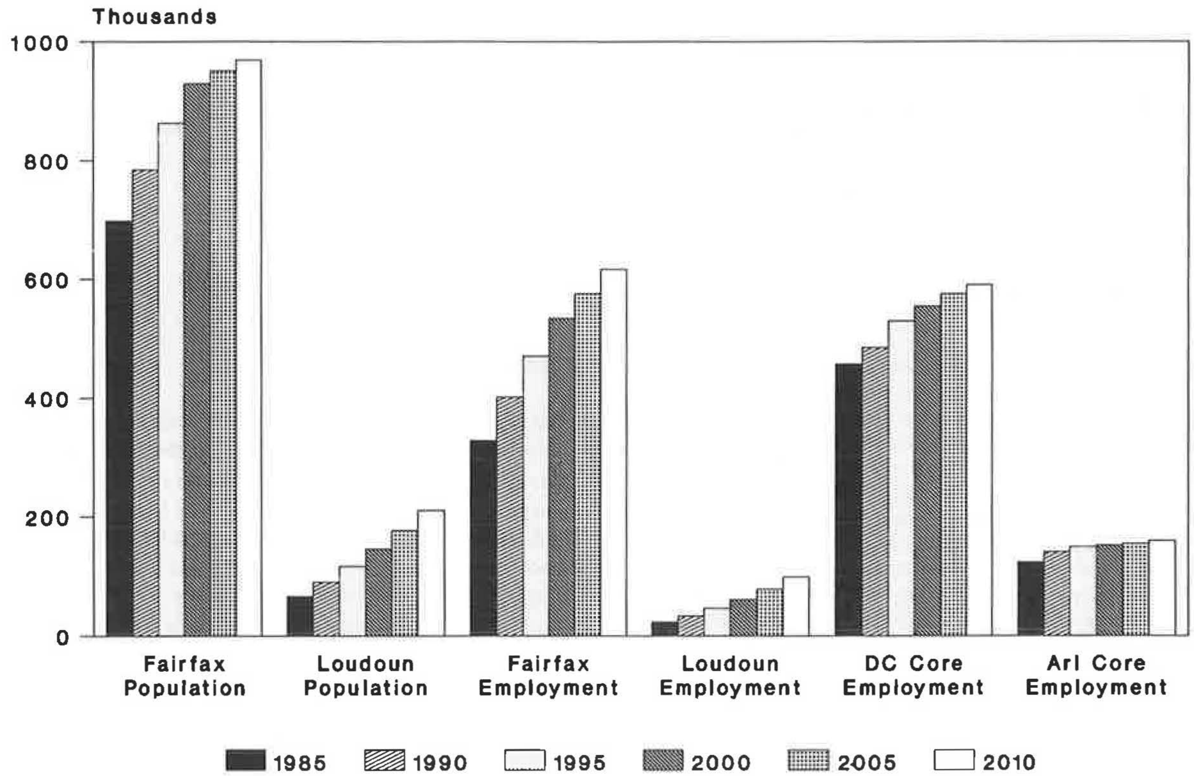


FIGURE 1 Population and employment.

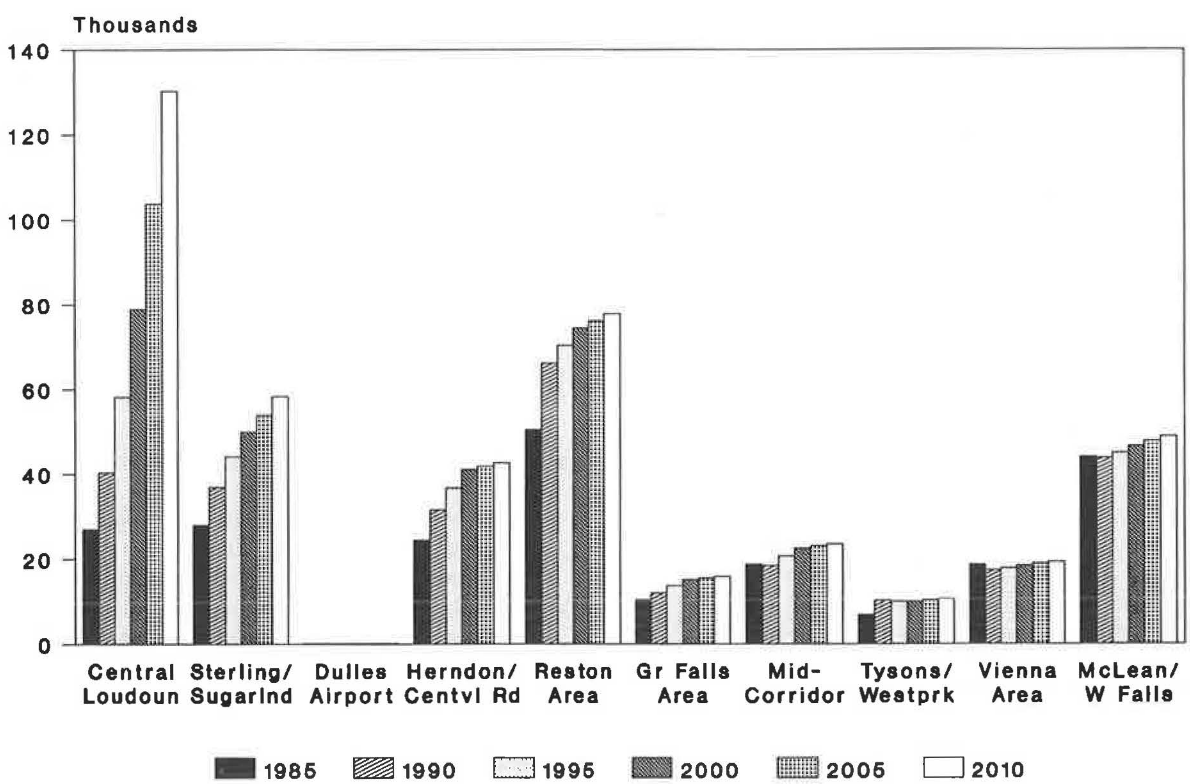


FIGURE 2 Corridor population.

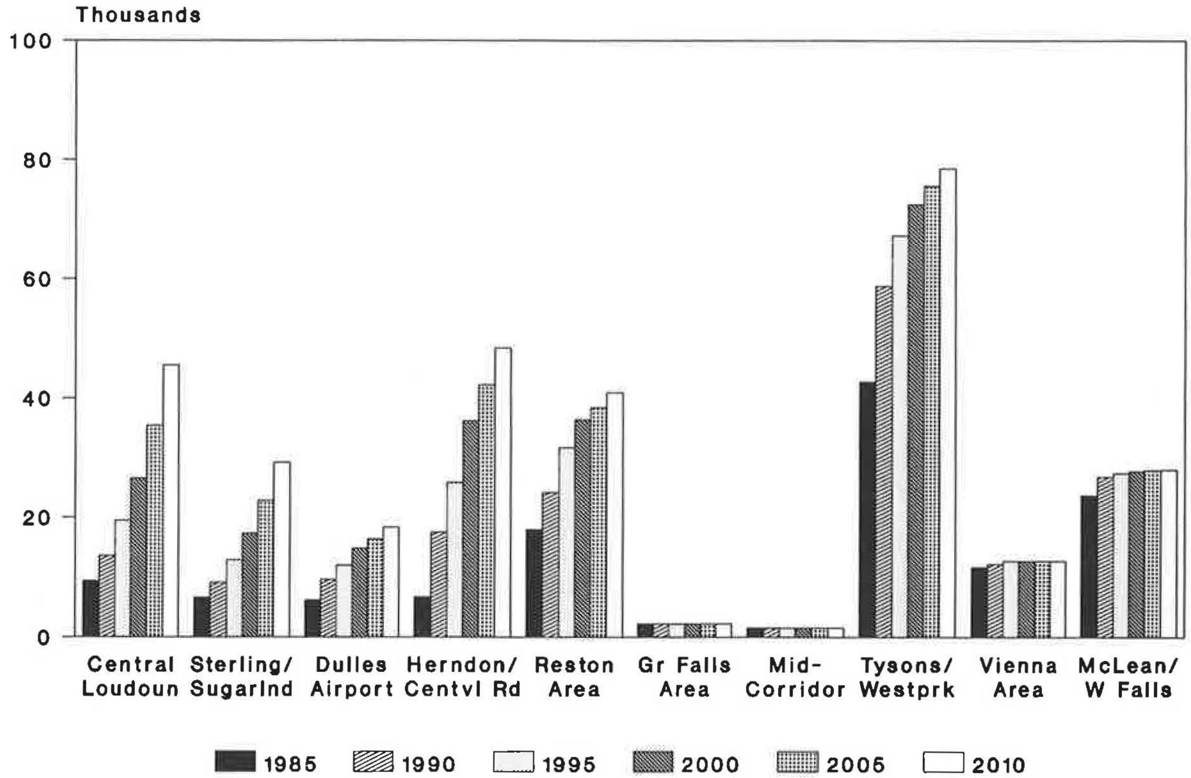


FIGURE 3 Corridor employment.

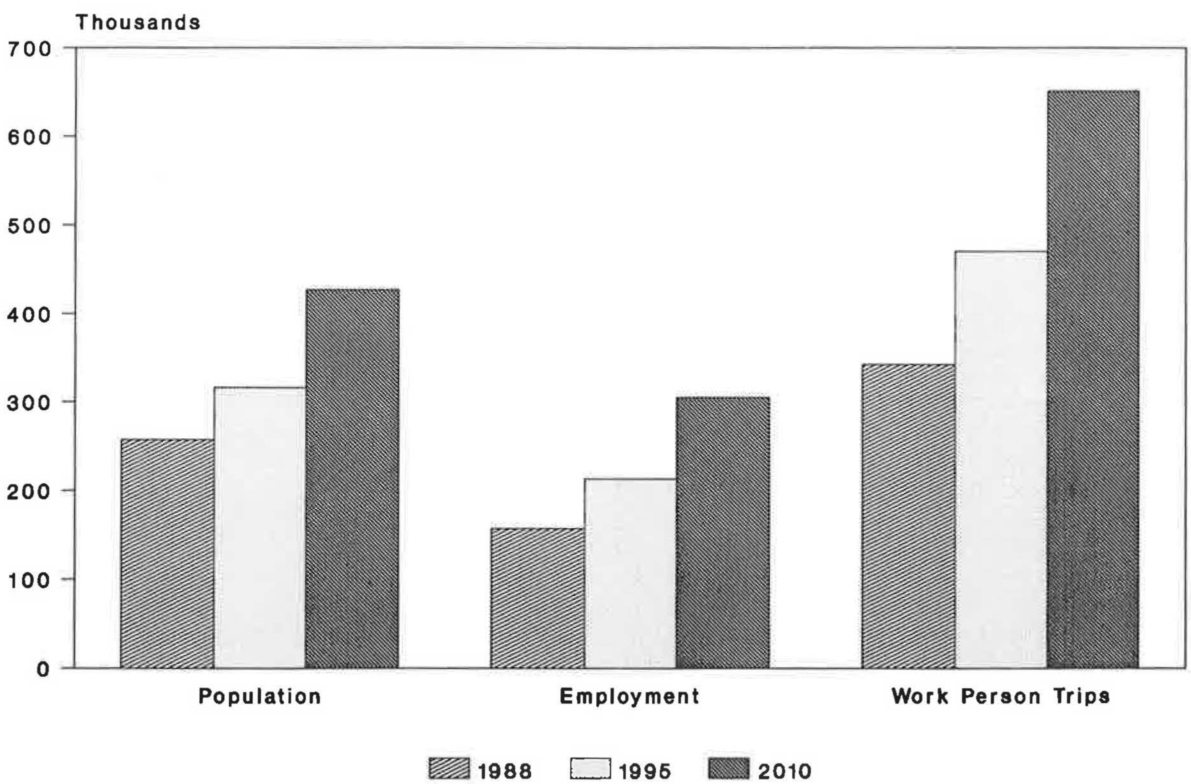


FIGURE 4 Work-related travel characteristics.

right-of-way would appear to be generous, once both the Toll Road and Access Road widenings are taken into account and accommodation is made for slip ramps, interchange improvements, and noise barriers, the space remaining for a transit facility is much more limited.

TRANSIT DEMAND ESTIMATION

The analysis of transit demand in the corridor required the development of procedures to deal with a variety of transit technologies as well as alternative station locations and operating plans. The demand estimation was performed using a microcomputer package, utilizing the logic contained in the regional planning models developed and maintained by the Council of Governments (COG). In a microcomputer environment, it was necessary to hold down the level of detail while still maintaining consistency with the regional process and providing appropriate sensitivity to the alternatives. The most important aspect of this consistency lay in the coding of access to transit, a common problem with other transit modeling studies.

The potential problem can be illustrated with a simple example. Area system geography is normally represented as a zone centroid connected to several adjacent intersections (Figure 5). Often, local bus service is provided through each connecting node (Figure 6). For some time, however, it has been standard modeling practice to recognize that not all of a zone may be able to walk to transit, and thus a transit walk area is defined around each transit route (Figure 7). The remaining part of the zone (and all zones not directly served by buses) is then assumed to be served using auto access to formal or informal park-and-ride facilities.

This type of coding is adequate for modeling conventional bus transit service, because the level of service at any given node is likely to be very similar and the all-or-nothing characteristic of conventional transit path building and assignment is not of major concern. An inconsistency arises, however, when a high-type transit service is introduced adjacent to part of a zone (Figure 8). In this case, the transit path is almost always via the high-type facility and, assuming that the percentage of the zone that can walk to transit still applies, will lead to overestimation of demand. In reality, a portion of the zone may have excellent service (Figure 9) while much of the zone is served only by local buses. In addition, the local bus service now may well require a transfer, further aggravating the problem.

The problem may be addressed in a number of ways, including developing a large number of small zones, particularly in the vicinity of transit stations, which can reliably be assumed to be either 100 percent walk to the high-type facility or require feeder access. This approach presents some problems in a transit alternatives study, such as that undertaken in the Dulles corridor, where station locations are unknown at the start and may be changed several times as the alternatives evolve. Also, increasing the number of zones results in some significant penalties with microcomputer processing.

The approach adopted for the Dulles study was to extend the two-path concept (walk and auto) used in the COG Washington model system to a system whereby the origin zone was divided into three potential areas: (1) walk to rail (or other high-type transit), (2) walk to feeder bus, and (3) drive to transit. At the destination end, two areas were identified: (1) walk directly from a transit facility, and (2) transfer to bus egress. Any destination area not served by transit is then considered unconnected, since outbound auto access is not a valid mode for most travelers.

This concept results in six potential transit paths (3 origin × 2 destination), as shown in Figures 10–16. Separate walk percentages for direct station access and bus access were esti-

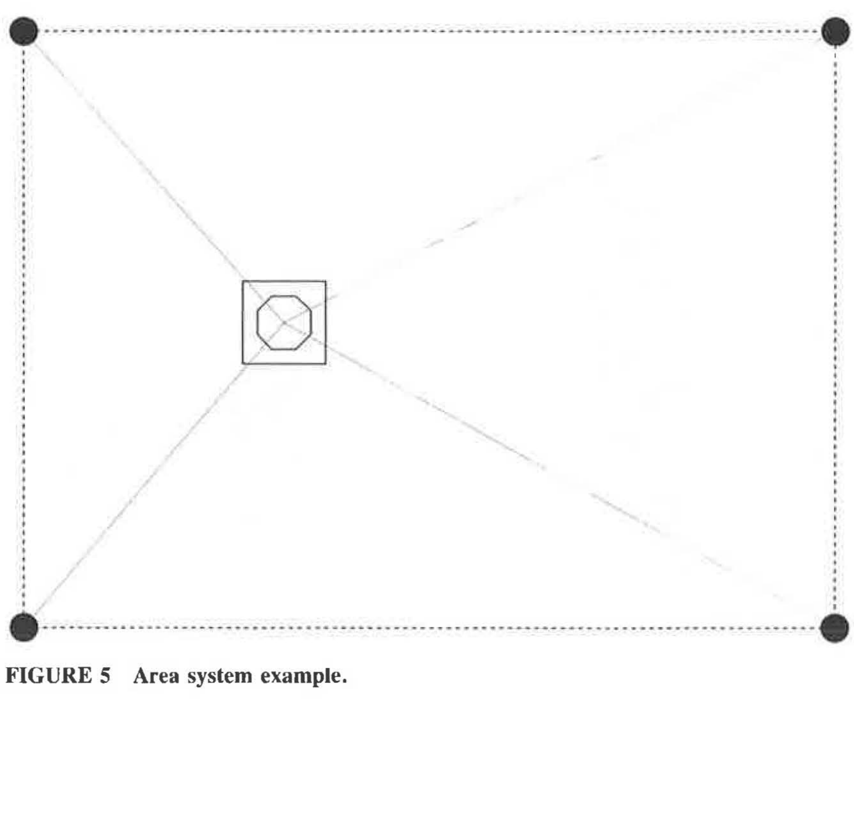


FIGURE 5 Area system example.

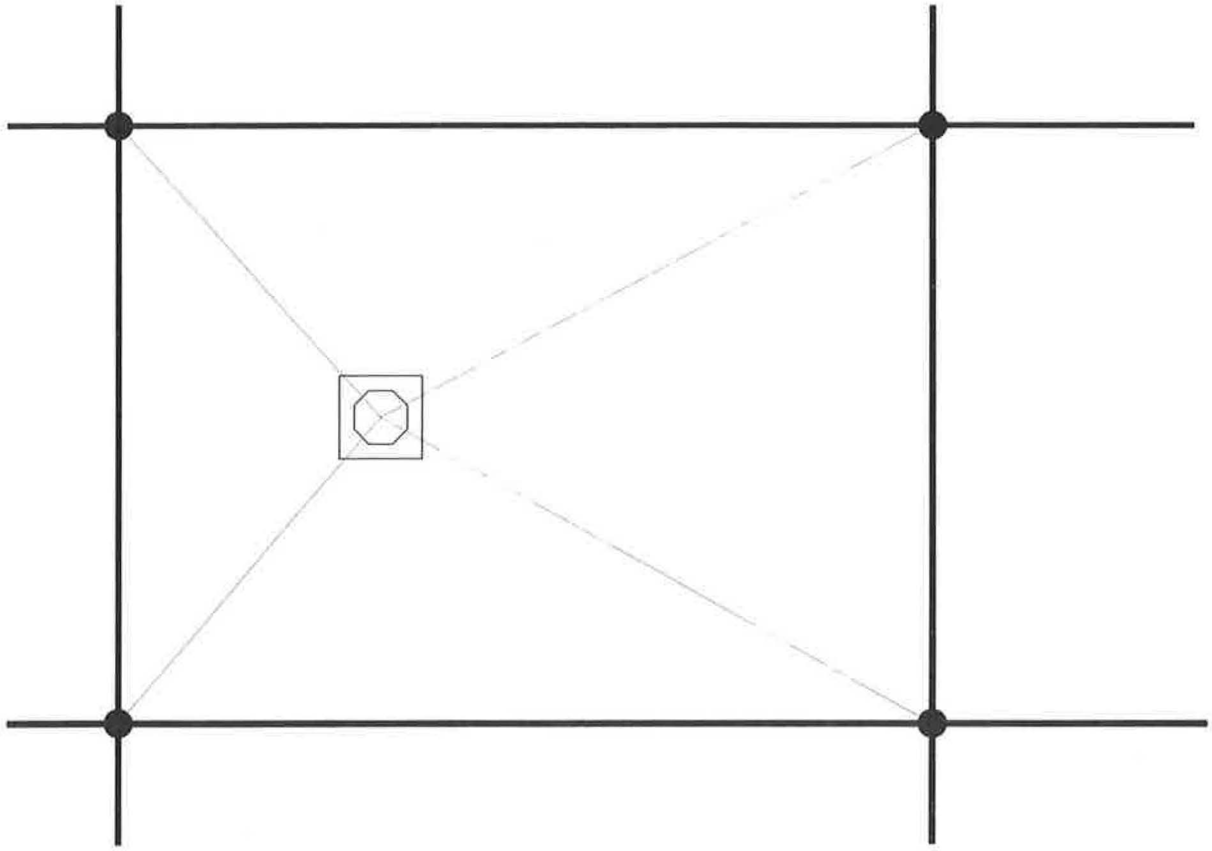


FIGURE 6 Local bus service through connecting nodes.

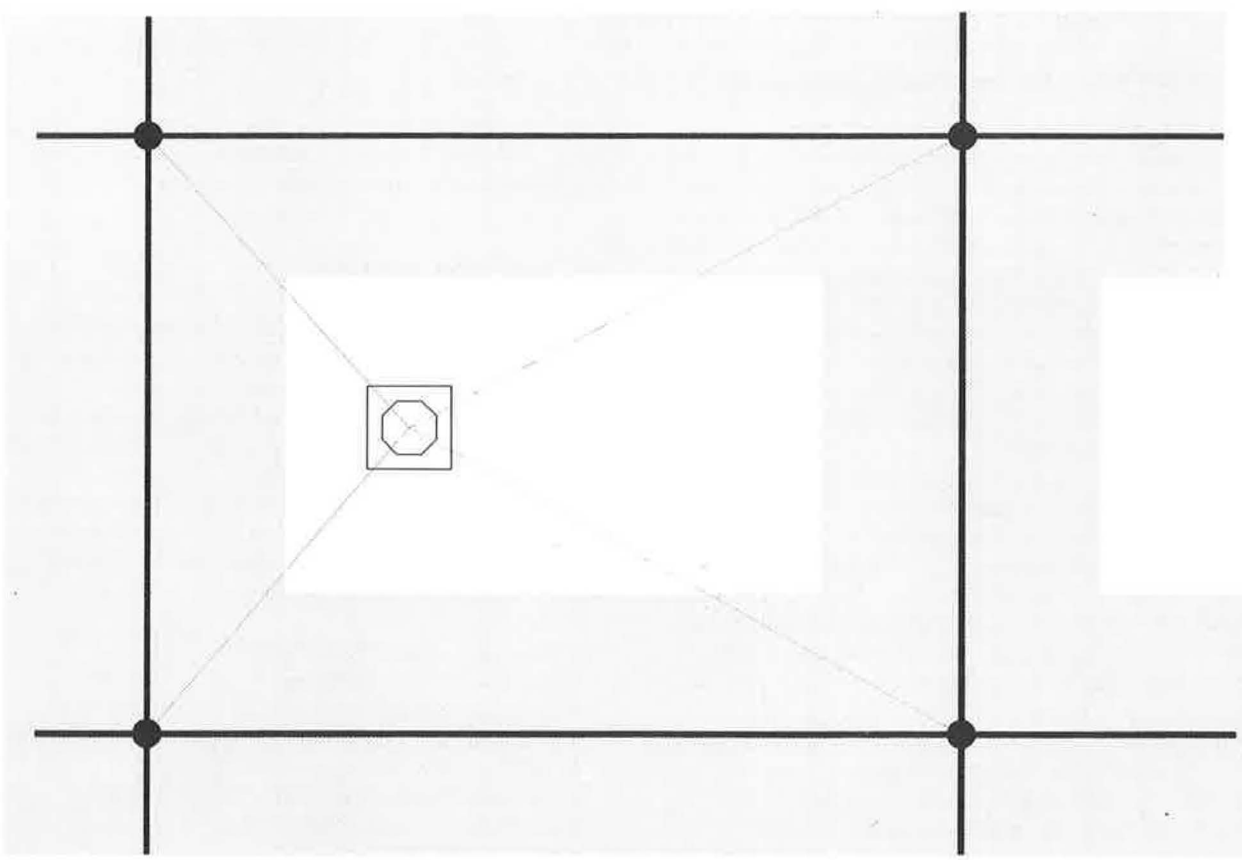


FIGURE 7 Transit walk areas around bus routes.

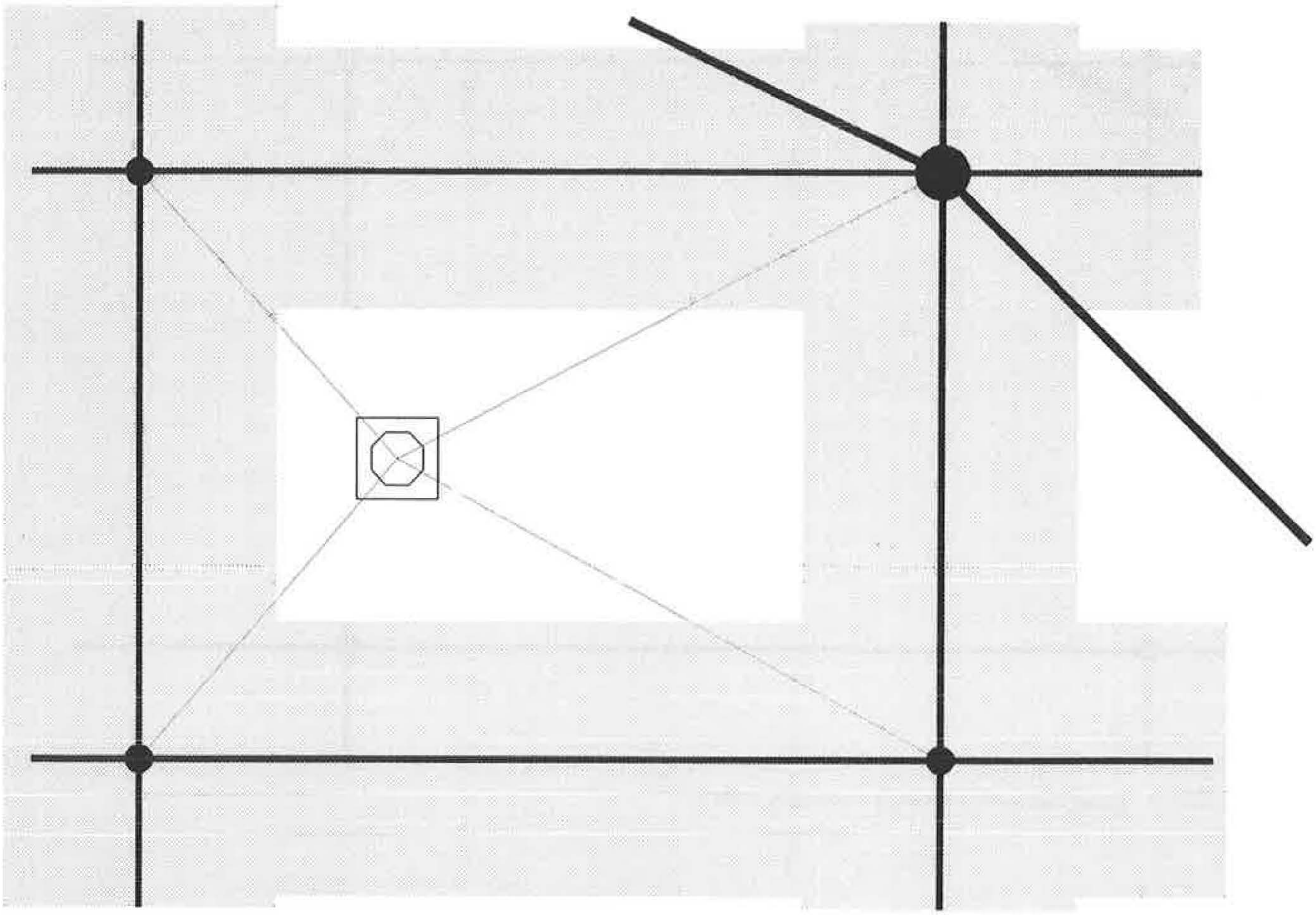


FIGURE 8 Addition of high-type transit service at one node.

mated for transit access and egress for each zone, and six potential transit paths were built and skimmed. The modal choice model was then applied for each set of path impedances, multiplied by the appropriate product of the origin and destination access percentages, and summed to produce a total interchange transit demand estimate. In practice, the transit trips on the six paths were maintained in the process for ultimate application of a simple mode of arrival model and assignment to the six individual paths. The assignment results were then combined to produce total loadings on the transit system components.

This approach offered great flexibility in the process, because a reliable estimate of the impact of moving or deleting transit stations could be determined simply by changing the access percentages, revising the transit line descriptions, and modifying the access links where necessary. The approach was also particularly relevant for this corridor, which did not include a direct downtown component, thus allowing the modeling to be undertaken using larger districts in the core area with negligible loss of accuracy.

The primary drawback to the approach was the need to generate six sets of transit paths, impedances, fares, and trip tables. Although each matrix remained modest in size, the number of matrices proliferated very rapidly and data storage, data management, and computer processing times increased significantly. The approach would thus seem to have great merit, but some offsetting consequences would need to be evaluated for any other potential application.

TRANSIT ALTERNATIVES

The development of the modeling procedures noted above and the identification of transit alternatives proceeded in parallel during the study, with decisions on the latter often influencing the design of the former. A total of nine transit alternatives were ultimately identified for analysis, combining the various technologies noted previously. These alternatives included an upgrading of conventional bus service as a transportation systems management (TSM) option, a grade-separated bus/HOV facility in the median of the Access Road/Toll Road, and a variety of rail options and technologies as follows:

- Base case (do nothing) [BASE];
- Transportation systems management [TSM];
- Busway/high occupancy vehicle lanes [HOV];
- Conventional light rail transit (LRT) [LRTA];
- LRT with Tyson's circulator [LRTB];
- Automated guideway transit (AGT) [AGTA];
- AGT with Tyson's loop [AGTB];
- Metrorail branch [METR]; and
- Rail hybrid [HYBR].

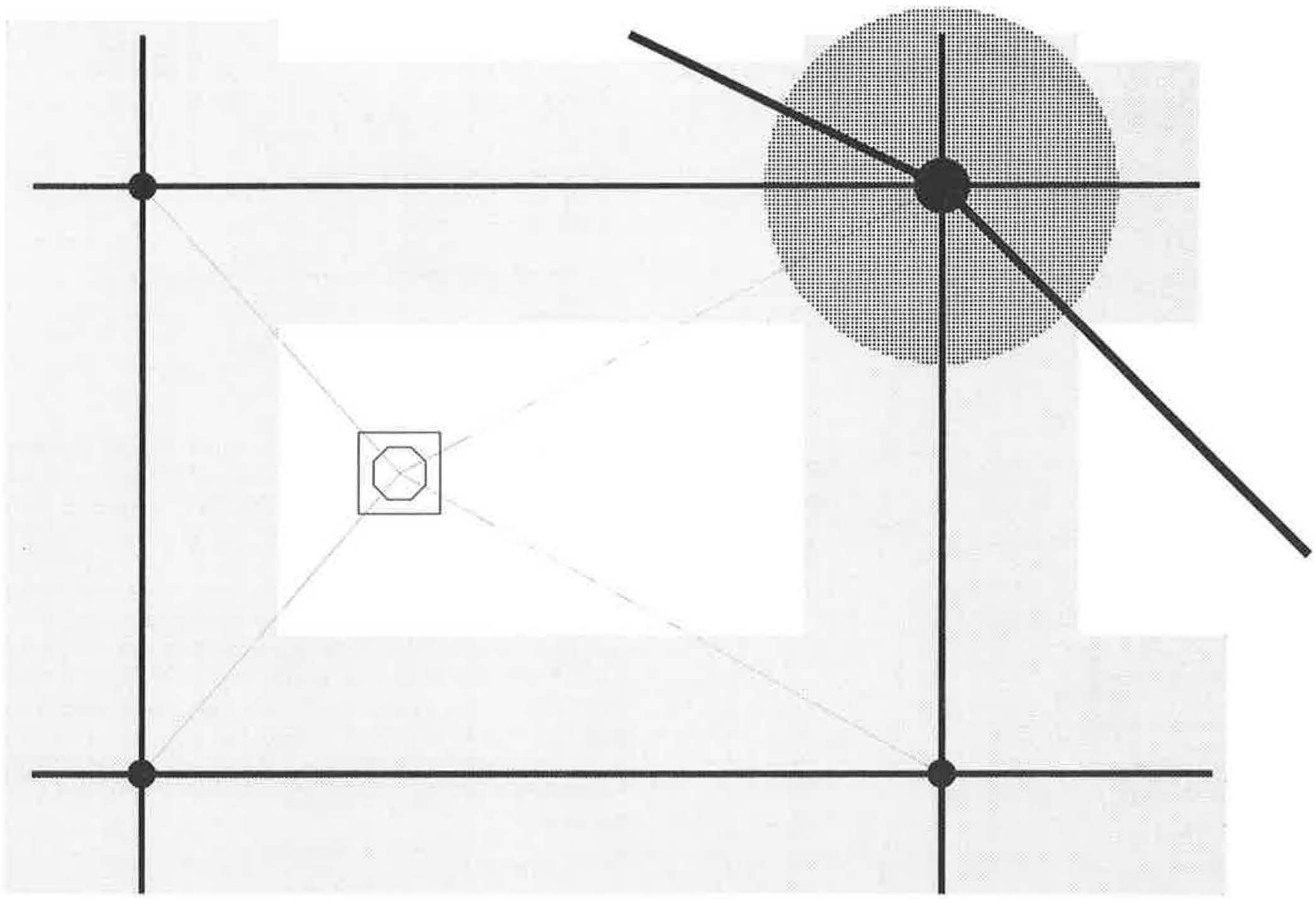


FIGURE 9 Improved service in part of zone may lead to overestimation of demand.

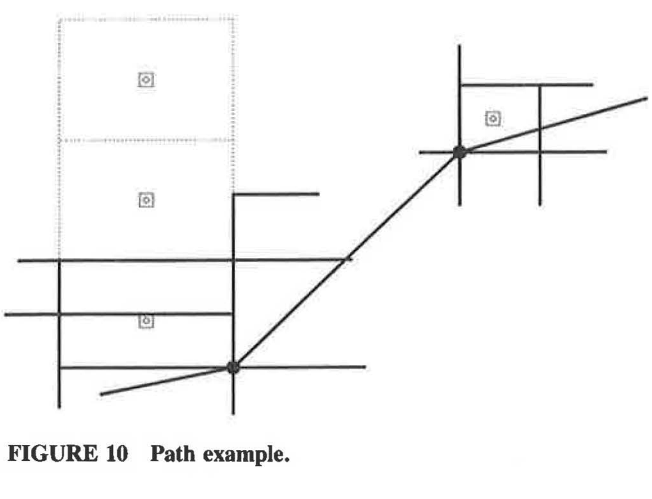


FIGURE 10 Path example.

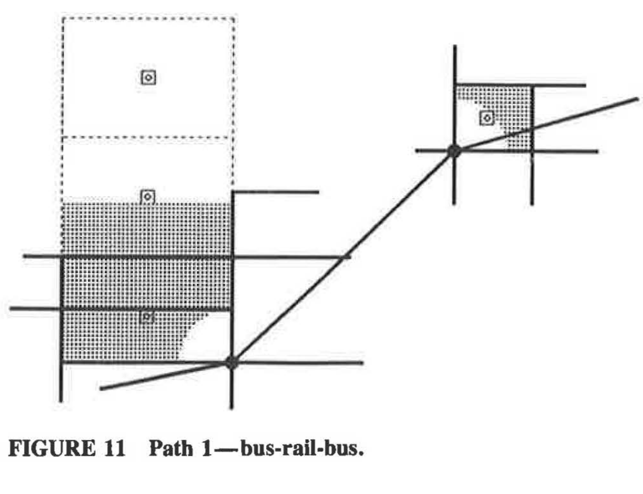


FIGURE 11 Path 1—bus-rail-bus.

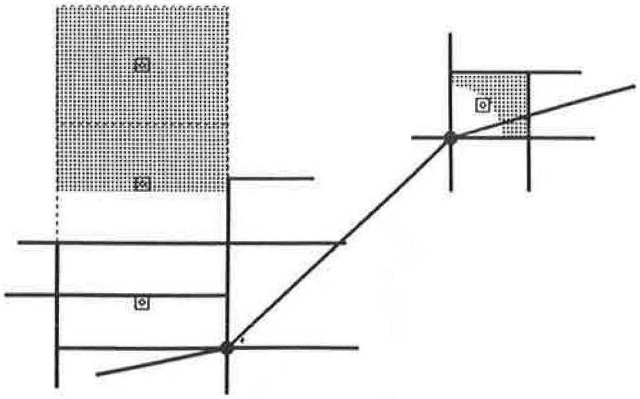


FIGURE 12 Path 2—auto-rail-bus.

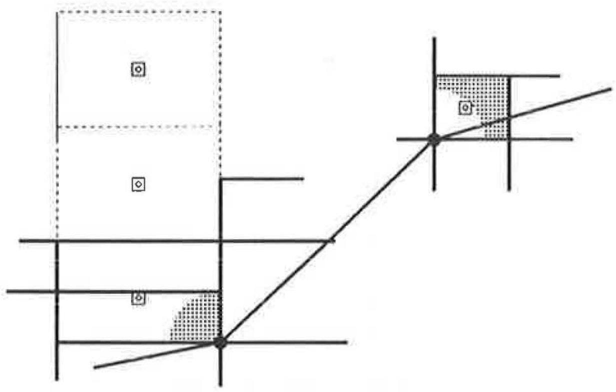


FIGURE 13 Path 3—walk-rail-bus.

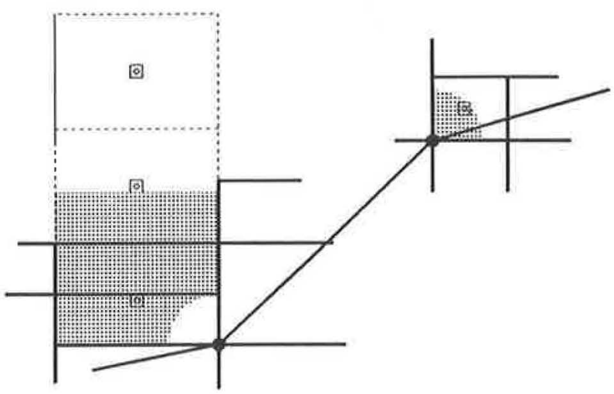


FIGURE 14 Path 4—bus-rail-walk.

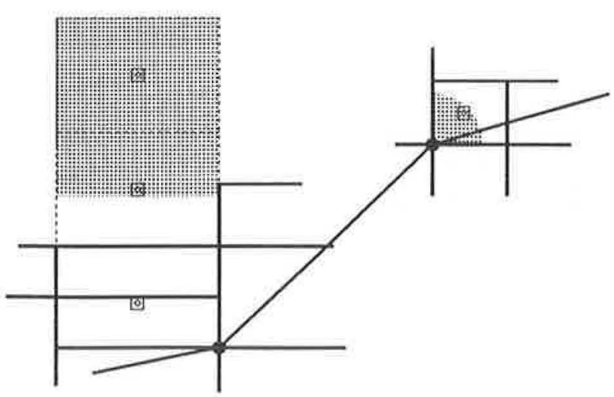


FIGURE 15 Path 5—auto-rail-walk.

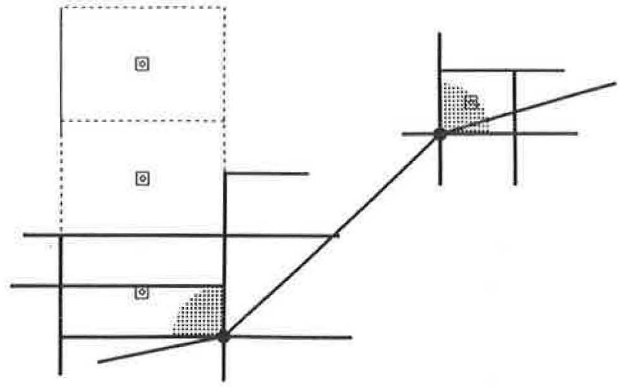


FIGURE 16 Path 6—walk-rail-walk.

All of the rail alternatives shared a common set of station locations, including the terminal stations at Dulles Airport and West Falls Church and six intermediate stations. A more limited set of stations was assumed for the TSM and HOV alternatives. Two alternatives also included an AGT system to serve the Tyson's Corner activity center. For demand estimation, an independent AGT loop was added to the baseline light rail alternative (LRTA) to produce a second alternative (LRTB) with a transfer at the Spring Hill Road station. Direct service through the Tyson's Corner area was explored with the AGTB alternative, which included two operating lines, one remaining in the Access Road right-of-way to West Falls Church and the other looping through the Tyson's Corner area.

TRAVEL DEMAND RESULTS

The various alternatives produced somewhat different travel times, although not nearly as different as those typically encountered in a corridor study due to the presence of the Access Road, which offers a largely uncongested roadway for express buses to West Falls Church in the TSM alternative.

Total corridor travel was the same in all alternatives (Figure 17), because a fixed person-trip table was used for all analyses. Overall transit demand levels were very similar, as might be expected from the similar travel times, and transit ridership only accounted for a rather small part of overall corridor demand. HOV usage was also very similar across the alternatives, since most HOV usage is "induced" by I-66 into downtown Washington, a common feature of all alternatives.

The analyses were undertaken for two horizon years, 1995 and 2010. The transit trip market is dominated by travel to the core (Figure 18), as is typical of a high-income suburban corridor, with the rail alternatives performing slightly better for internal travel than the bus alternatives. On a geographic market basis, transit is shown to capture a significant share of the travel to the core, but as noted previously this is a very low-growth market (Figure 19).

The total corridor travel is important in overall project evaluation but masks differences between the alternatives, because significant travel from the inner parts of the corridor is not affected by many of the alternatives. The differences in transit guideway ridership is greater among the alternatives,

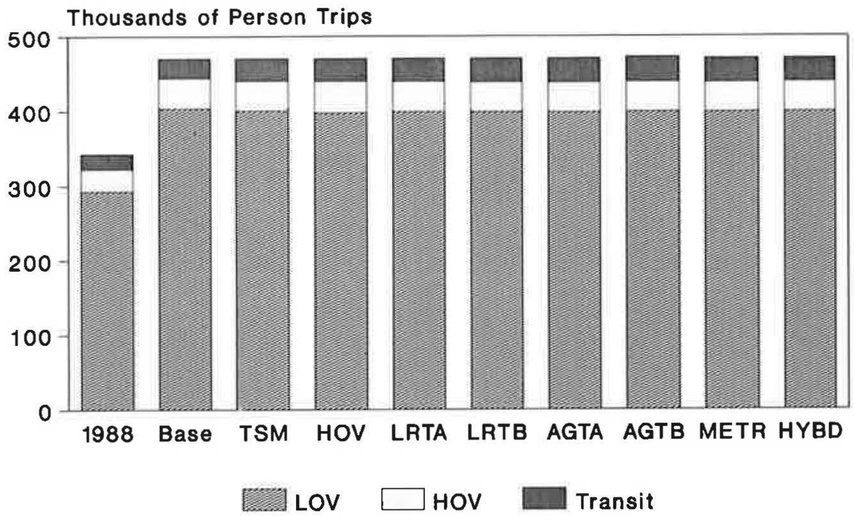


FIGURE 17 Total corridor work travel (1995 average weekday).

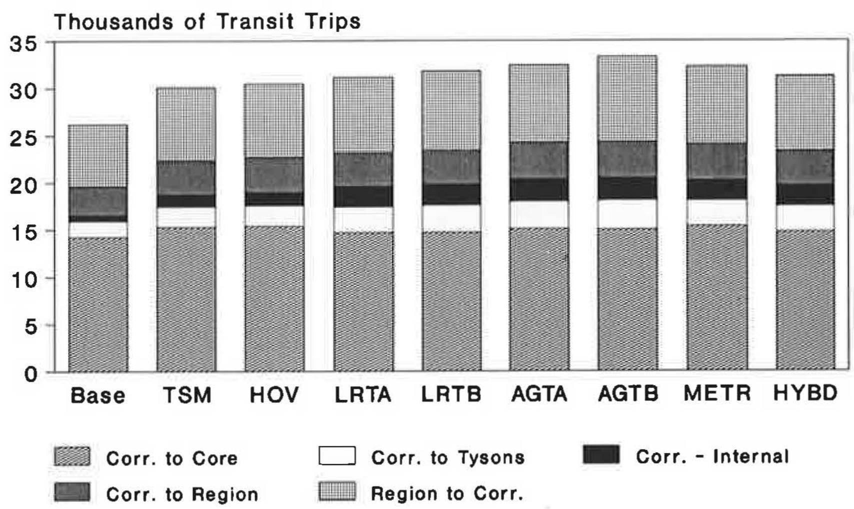
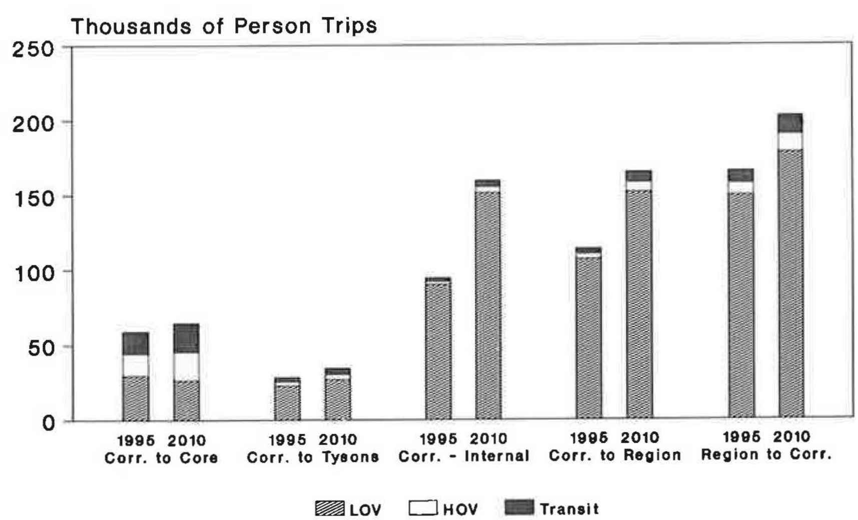


FIGURE 18 Corridor transit work trips by market (1995 average workday).



Assuming LRTA alternative

FIGURE 19 Summary of corridor work trips by mode by market.

with the AGTB alternative with direct service to Tyson's capturing the largest ridership (Figure 20). This result occurs since this alternative provides guideway service for virtually all outbound commuters from Metrorail to the entire Tyson's Corner area, while many commuters use local buses from the West Falls Church station in the other alternatives.

COSTS AND REVENUES

The operating costs for the various alternatives show that the additional rail operating costs are not fully offset by a reduction in bus operating costs (Figure 21), largely because the bus service that is replaced is high-speed, efficient service via the Access Road. Operating revenues are somewhat higher for the rail alternatives, however, due to higher ridership and a somewhat different fare structure, so the overall subsidy (Figure 22) for the simpler rail alternatives is about the same as for the bus alternatives.

The operating costs for Metrorail are much higher than for the other rail alternatives, not so much because of inherent differences in the technologies as the necessary differences in implementation. In the other rail alternatives, the service terminates at West Falls Church with a transfer. The Metrorail alternative, however, is a branch of the existing Orange Line, with alternating trains serving the current Vienna terminus and the proposed Dulles line. Because of downstream capacity problems, it is necessary to run longer trains on Metrorail than are required to serve the corridor demand alone, thus increasing car miles and operating costs.

The capital costs for the alternatives are vastly different, with the rail alternatives ranging from over $500 million to nearly $800 million in 1988 dollars (Figure 23). The HOV alternative requires approximately $200 million, much of it to rebuild the existing bridges over the Access Road and Toll Road to eliminate operationally unacceptable piers in the middle of the roadway. By contrast, the capital costs for the TSM alternative are less than $100 million.

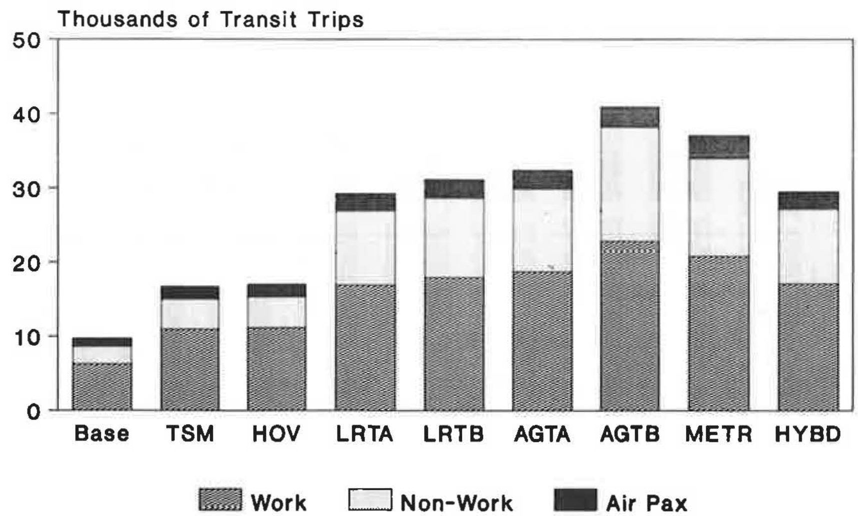


FIGURE 20 Transit guideway ridership by purpose (1995 average workday).

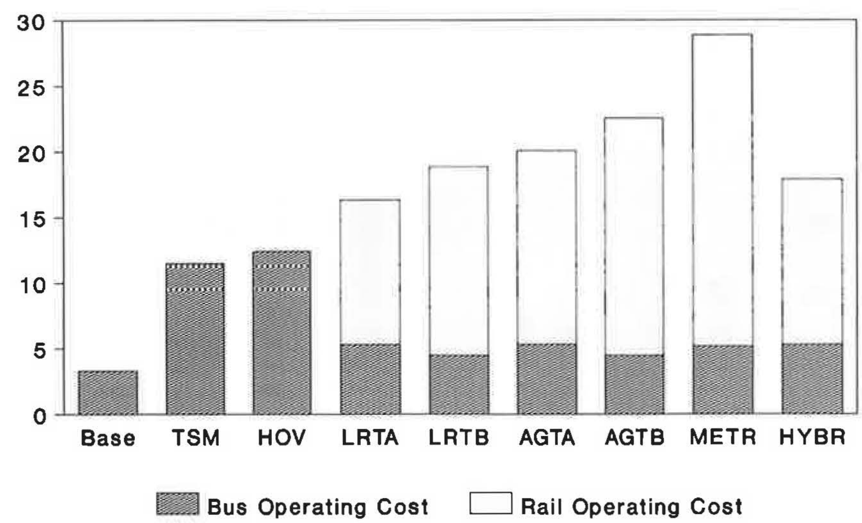


FIGURE 21 Annual corridor operating costs (1995, in 1988 dollars).

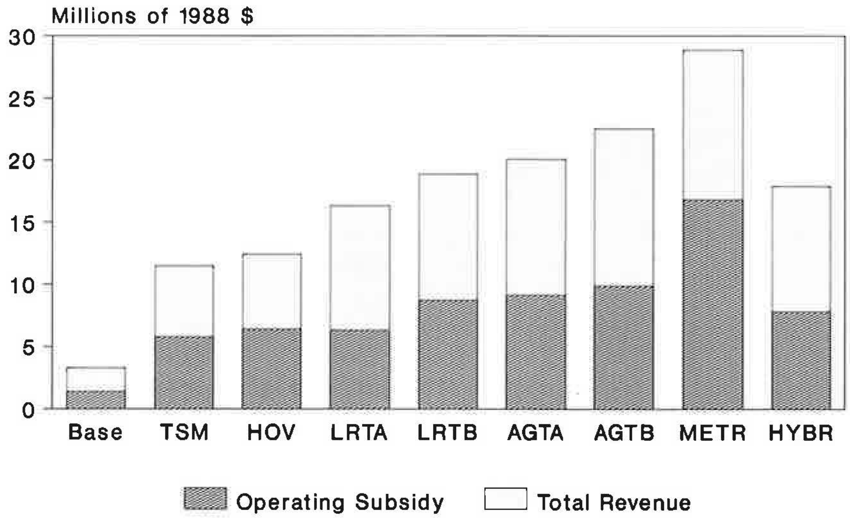


FIGURE 22 Annual operating cost, revenue and subsidy (1995, in 1988 dollars).

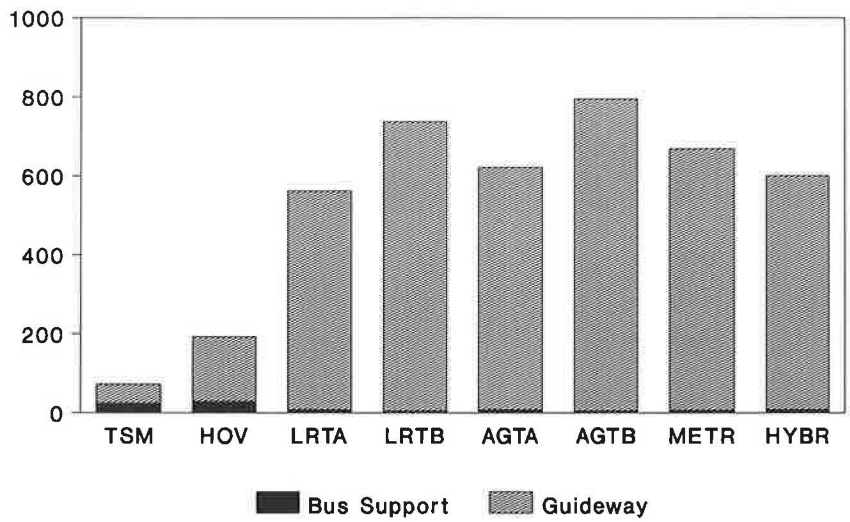


FIGURE 23 Capital cost summary (millions of 1988 dollars).

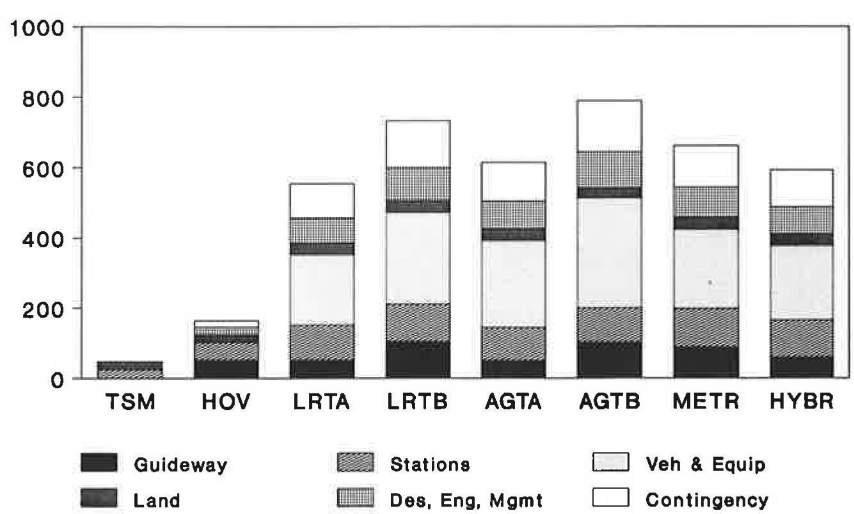


FIGURE 24 Guideway capital costs (millions of 1988 dollars).

The guideway costs for the various alternatives include the actual guideway facility itself, stations, vehicles and equipment, land, and allowances for design and contingencies (Figure 24). The vehicles and equipment costs are the largest part of the total and include an almost equal breakdown into trackwork, power, signalling, communications, vehicles, and maintenance facility components.

CONCLUSIONS

The unique features of the corridor profoundly affected the results of the analysis. A cost-effectiveness analysis following the guidelines of the Urban Mass Transportation Administration showed that rail investments did not reflect a cost-effective increment over the TSM condition. In addition, competing needs for transportation resources in the Washington area also appeared to argue against immediate pursuit of a rail option.

As a result, the study concluded that an aggressive bus-based transit system be developed in the corridor, while preserving the median alignment and identifying and preserving station sites for ultimate implementation of fixed guideway service at a future date. These recommendations were adopted by the Fairfax County Board of Supervisors (the client for the study), and steps are being taken to implement the recommended plan.

ACKNOWLEDGMENTS

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